ANNUAL REPORT

OF THE

MAINE STATE COLLEGE

Agricultural Experiment Station,

1889.

BANGOR:
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1890.

MAINE STATE COLLEGE.

AGRICULTURAL EXPERIMENT STATION.

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L. H. MERRILL, B. S., ... Chemist.

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TREASURER'S REPORT.

THE MAINE AGRICULTURAL EXPERIMENT STATION.

In account with

THE UNITED STATES APPROPRIATION,

1888-9	*Cr.*	*Dr.*
To receipts from the U. S. Treas. for the year ending June 30th, 1889......		$15,000 00
By Salaries......	$7,504 22	
" Chemical Laboratory......	2,199 05	
" Field and Feeding Experiments........................	1,526 18	
" Printing	862 80	
" Construction	750 00	
" Department Veterinary Science........................	657 27	
" Department Botany and Entomology...............	108 45	
" Department Meteorology..................................	35 00	
" Department Horticulture..................................	113 39	
" Live Stock..	292 53	
" Library..	261 40	
" Stationery and Postage....................................	23 87	
" Travelling Expenses..	161 25	
" General Expense..	504 34	
		$14,999 75
Unexpended Balance		$0 25

GEORGE H. HAMLIN, Treas.

DIRECTORS' REPORT.

M. C. Fernald, Ph.D., President Maine State College:

SIR:—The accompanying report of the Experiment Station which I have the honor to submit, contains a statement of the expenditures of the Station for the fiscal year ending July 1st, 1889, and a full account of the operations of the Station for the working year ending January 1st, 1890.

It is gratifying to be able to state that the year 1889 has been one of substantial progress, in which the equipment has received valuable accessions, the scope of work enlarged, and the lines of future experiments and investigations more definitely established.

The value to practical agriculture of the results so far secured will in part be determined by the nature of these results, and in part by the manner in which they are received by the intelligent farming public. The Experiment Station fulfills its duty when it spreads broadcast over the State the results of its work, but its labor will be fruitless to that great industry for whose benefit the Station was established, unless the facts revealed by experiment and investigation are properly studied and assimilated.

THE ORGANIZATION OF THE STATION.

The relations of the Station as a department of the College to the Trustees and to the Station Council established by the Trustees, are fully set forth in the report of the Station for 1888. Since the writing of that report the Trustees have authorized an important change in the Station Council, namely: the addition to it as advisory members of one representative from each of the following organizations: the State Board of Agriculture, the Patrons of Husbandry and the State Pomological Society. These organizations have fortunately selected as their representatives men of recognized ability, who are thoroughly conversant with the conditions and needs of the agriculture of the State, and who will be able to give to the working force of the Station advice and assistance that will be invaluable. These gentlemen have already met with the Station Council, and if any doubt had heretofore existed as to the wisdom of the action of the Trustees, it was entirely dispelled by a prompt recognition of the advantage in being able to confer directly with those who stand in close relation to the farming public.

The meetings of the Station Council as newly constituted have been characterized by a cordiality and unanimity that are very encouraging, and that are a prophecy of future success.

Station Equipment.

The most important addition to the Station appliances during the past year has been the equipment of a barn in a manner especially adapted to experimental feeding. The barn contains a fine basement, the floor of which is solid ledge, which is to be used for storage of manure, pens for swine, &c. The south side of the barn contains a hospital, stalls for cows and for young stock and three stalls for horses. Midway between two apartments devoted to stalls are scales set in the floor in a manner admirably adapted to the weighing of animals. On the other side of the barn is a silo, a space for the storage of implements, stalls for the weighed rations of hay, room for the storage of the samples of grain and other crops, a well arranged granary and an appartment fitted up for the performance of digestion experiments. These rooms are all sheathed in a neat manner and the entire arrangement seems likely to prove very convenient and satisfactory.

A fairly complete outfit of bacteriological apparatus has been purchased for Dr. Russell, and has been placed in the new Station building. Important additions have been made to the meteorological apparatus also. The Station building has within the year been supplied with river water in place of the insufficient supply previously available. The College is certain to erect a greenhouse in 1890, as the needed funds have already been appropriated by the State for that purpose. This will make it possible to increase the work done in the interests of horticulture.

The Station Work.

It was frequently remarked through the columns of the Agricultural press at the time experiment stations were being organized under the Hatch Act, that these stations should deal largely with agricultural problems through the actual practice of agriculture, or, in other words, it was demanded by certain writers that they should do a large amount of farming. While this view of the matter is likely to appeal strongly to popular favor, it is doubtful whether it is a correct view.

The conditions surrounding the practice of agriculture differ with every state, with every township, and almost with every farm.

It is not possible for the experiment station operating at one point in the State, or even at a half dozen points, to prescribe set methods or rules that can be successfully applied to the State as a whole. The practice of agriculture is like the practice of medicine—there are certain principles underlying the use of medicines in all cases, and it is left to the judgment of the practitioner how to make use of these principles, just as in farming there are certain principles underlying the growth of crops or of animals, or production of any sort, and it is left to the farmer to use his judgment in incorporating those principles into his practice. It is a knowledge of principles and underlying facts of which we are in great need, and the true work of the experiment station is to discover these.

To do more than this, except to a very limited extent, is to encroach upon a province which can only be occupied by the intelligence and good judgment of the farmer. For instance, it would be unwise for the Experiment Station to formulate set rules for the guidance of butter makers, whereas, it can no more surely accomplish its true work than by discovering the effect of certain methods of manipulating milk upon the final yield of butter; neither could the Station make up a ration for feeding milch cows that would be economical at all times and in all places, but it can do no better thing than show the effect upon growth and milk of certain combinations of food ingredients, and then leave it to the business management of the farmer to secure these ingredients in the cheapest possible way. Of course in the matter of the use of insecticides, or in the treatment of the diseases of plants and animals, definite methods may very properly be advised, because here a successful method would be almost universally practicable.

In accordance with these views the policy of the Maine Experiment Station will be to deal largely with the discovery of those facts and principles of importance to the whole State, without attempting to incorporate the results of its experiments and investigations into set methods.

To be sure the Station is doing more or less farming and is engaged in feeding and in dairying, but this is done only as a means to an end, the end to be reached being a knowledge of principles or facts. The practice followed in the Station farming may, or may not be, the best one, and may, or may not be, of general application, but it is supposed to be such practice as will

most quickly and surely answer certain questions. A problem may be as satisfactorily solved by bad practice as by good, in fact bad practice may be necessary to its solution. These statements are made in order to caution against judging the usefulness of the Station by the standards which we would apply to those engaged in the business of farming. The chief considerations in measuring the usefulness of the Station work are: 1st, Have its experiments and investigations any important relation to the agriculture of the State? 2d, Are its statement of principles or of facts well sustained by the data of experiment and investigation?

The Station Publications.

The records of the work of the Station for the year 1889, have been published in two bulletins, Nos. 1 and 2, Second Series, and in the Annual Report for 1889, which is issued in three parts, Part 1 in September, 1889, Parts 2 and 3, as early as possible in 1890.

Of each publication of the station, there is printed at the present time an edition of seven thousand five hundred copies. While the mailing list of the Station has not yet reached six thousand names, this list is constantly increasing, and the unused copies of reports and bulletins now being issued will be needed in the future by those who may desire to complete their sets.

The Station is at present supplying its publications free to all those outside the State who request them, but our outside list is assuming such formidable proportions that it may be necessary in the near future to make a small charge for the reports sent out of the State, sufficient to cover the cost of printing. Of course exception will be made of other experiment stations and their officers.

Experiments and Investigations.

There was published in the Station Report for 1888, a list of the experiments and investigations which have been completed, were already undertaken, or planned. Of those there recorded further attention has been given, or will be given to Nos. 7, 8, 9, 11, 19, 21 to 26 and 30 to 42.

The following experiments and investigations have been added to the list, some of which have already been entered upon, and the others are to receive attention in the near future.

(43) Fertilizer Experiments with Orchards.

Object: A determination of the most efficient means of fertilizing worn out orchards.

Time: Summer of 1890 and continuing.

(44) Investigation.

Object: A determination of the loss of fertility incurred in selling sweet corn to factories, and the percentage of manurial and food value contained in the whole crop that is removed in the kernel.

Time: Summer of 1889, and continuing.

Results published: First year in Report M. E. S. 1889, pp. 286-7.

(45) Field Experiment.

Object: To determine whether the fertility of the soil can be as effectually and economically maintained by the use of commercial fertilizers as by farm manure.

Time: Summer of 1890 and continuing.

(46) Experiment.

Object: To illustrate the fertilizing qualities of liquid manure.

(47) Experiment.

Object: A determination of the availability of the potash in potash feldspar as a source of potash for the potato crop.

Time: Summer of 1890.

(48) Investigation.

Object: A determination of the effect of an abundant supply of potash salts on the composition of the kernel of sweet corn.

Time: Summer of 1890.

(49) Experiment with Fodder Production.

Object: A determination of the relative amount of food value produced by the grains sown alone, and in various mixtures.

Time: Summer of 1889, and continuing.

(50) Digestion Experiment.

Object: A determination of actual and relative digestibility of wheat middlings and wheat bran.

Time: 1889.

Results published: Report M. E. S., 1889, pp. 61-65.

(51) Feeding Experiment.

Object: To determine the effect upon milk production of chop-

ping the hay and mixing grain with it after its being moistened.

Time: 1890.

(52) *Feeding Experiment.*

Object: To determine the value of ground oats for swine.

(53) *Feeding Experiment.*

Object: Feeding value of mixed grains raised on the farm as compared with purchased foods.

(54) *Investigation.*

Object: To determine the influence of linseed meal on the flavor of butter.

(55) *Feeding Experiment.*

Object: To determine the most economical rations for fattening sheep with special reference to the use of roots.

(56) *Feeding Experiment.*

Object: To determine the relative value of oats and a mixture of other grains as foods for producing growth in colts.

Time: 1890.

(57) *Investigation.*

Object: To determine the relative production of digestible dry matter in various fodders and root crops.

Time: 1890.

(58) *Culture Experiments.*

Object: To test the charistics of growth of various varieties of grasses.

Time: Summer of 1888, and continuing.

Results published: Report 1890, pp. 161-171.

(50) *Investigation.*

Object: To ascertain the causes of potato scab.

(60) *Spraying Experiment.*

Object: To ascertain the efficacy of spraying certain liquids on apple trees for the prevention of apple scab.

Time: Summer of 1890 and continuing.

(61) *Investigation.*

Object: Trace the life history of potato rust and rot.

Time: 1890.

(62) *Spraying Experiment.*

Object: To determine the value of certain insecticides for the

prevention of the cabbage worm.

Time: Summer of 1890.

(63) Germination Tests.

Object: To determine the effect upon their vitality of keeping seeds.

Time: 1890 and continuing.

(64) Spraying Experiment.

Object: To determine the minimum amount of Paris Green necessary in preventing the potato beetle.

Time: 1890.

(65) Investigation.

Object: To determine the life history of the apple maggot and the best means of preventing its ravages.

Time: 1888, and continuing.

Results published: Bulletin No. 2, second series, and this Report pp. 190-241.

(66) Experiment.

Object: To determine the economy of caponizing cockerels.

(67) Investigation.

Object: The study of hog cholera and swine plague.

(68) Experiment.

Object: To determine the conditions favorable to the communication of tuberculosis from one animal to another.

Time: 1890.

(69) Investigation.

Object: A study of the disease known as actinimycosis (lump on the jaw.)

(70) Investigation.

Object: A study of parturition fever.

(71) Experiment.

Object: Test of the economy of egg and meat production with certain breeds of poultry.

Time: 1890, and continuing.

(72) Culture Experiment.

Object: To test the value of new varieties of large and small fruits in various parts of this State.

Time: 1890, and continuing.

ACKNOWLEDGMENTS.

It gives me great pleasure to state that the relations which my associates have sustained toward myself and one another have been of the most pleasant character. The Station force seems to be working together in a spirit of cordial co-operation which is very gratifying, and whatever work may have been accomplished that is creditable, is not due to the efforts of any single person, but to the Station officers as a body.

Public opinion is very apt in approving or condemning the work of a particular experiment station to place the praise or blame largely upon its director. In a sense that is right, because it is in general his duty to make an effort that only efficient men and means find a place in the Station equipment; but after all, the success or failure of the station and the scientific and practical value of the results that it reaches, are very largely determined by the enthusiasm and care which each station officer gives to his work.

The officers of the Station have been greatly encouraged by the readiness with which the farmers of the State have responded to calls for information and to requests for assistance in conducting experiments.

The Station finds it necessary to carry on a certain amount of work in various parts of the State, more or less distant from the Station, and this is made possible only by the cordial co-operation of intelligent farmers.

Each year it will be found necessary to make tests of fertilizers and insecticides on farms and in orchards in various parts of the State, besides which it is proposed to distribute varieties of fruits to be grown in different localities, and we may expect from this work valuable results.

The share which each Station officer has had in the work accomplished during the past year is in general indicated by the contents of this Report. It is but fair to say, however, that the amount of work accomplished by the Station chemists, Mr. Bartlett and Mr. Merrill, is much larger than would appear from the printed matter with which their names are directly associated. As a matter of fact the most laborious part of the work pertaining to analyses of cattle foods, digestion experiments, tests of diary breeds, and especially inspection of fertilizers, has fallen upon them. Attention is called to the work of the Station chemists, not for the purpose of giving especial prominence, but rather that

its real importance, which may not be so apparent to anyone not intimately acquainted with the methods of work, may be appreciated. Scarcely anything has been done in the investigation of fertilizers, foods and dairy products, in which the aid of the chemical laboratory has not been a large and essential factor.

W. H. JORDAN,
Director.

MAINE STATE COLLEGE,
Orono, Me., Dec. 31st, 1889.

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INSPECTION OF FERTILIZERS.

The Station has examined, since the latter part of March, 1889, ninety-one samples of fertilizers, representing forty-three brands. These samples were collected by an authorized agent of the station, who has visited various places in the State for that purpose, since the shipment of fertilizers for 1889 began.

The brands offered for sale this year are practically the same as those sold in 1888, two or three new ones having made their appearance. Each year brings a small increase to the number of commercial manures which are found in Maine markets, and we may believe that the quantity of these goods purchased by our farmers is yearly growing larger. Whether the expenditure of so much money in this way is wise may not properly be discussed in this connection, but it is fair to assume that this expenditure would not be kept up increasingly, year after year, unless it is found to be profitable.

OBSERVANCE OF THE FERTILIZER LAW.

In any case the duty of the Station in the character of an inspector is to show as accurately as can be determined what is the composition and value of the fertilizers sold in the State. This is to be done under the sanction of a state law, the main provisions of which are as follows:

(1) The "manufacturer, company or person" offering a fertilizer for sale in the State shall register "annually, on or before the first day of March," in the office of the Maine Agricultural Experiment Station, "the name or trade mark under which the fertilizer is sold, the name of the manufacturer and the place of manufacture."

(2) Each package of every fertilizer selling for more than ten dollars per ton shall be marked with the weight of the package the percentages of available nitrogen, phosphoric acid and potash, and the names of the fertilizer, manufacturer and place of manufacture.

(3) The Experiment Station is authorized to select each year, from each brand of fertilizer offered for sale in the State at least three samples from three different places in the State. These samples shall be selected in the presence of some representative of

the manufacturing company, and a duplicate sample shall in each case be left with this representative.

The first provision of this law has not been properly observed. Notwithstanding the fact that there has been issued in February of both 1888 and 1889, from the office of this Station, a circular letter stating the law and calling attention to its requirements, which was addressed to all but one of the parties whose goods are now sold in the State, only a minority of the manufacturers took the trouble this year to make the required statement concerning the brands of fertilizers they proposed to put on the market in Maine. Those who did comply in 1889 with this part of the law are as follows:

Bradley Fertilizer Co., Boston, Mass.
Crocker Fertilizer and Chemical Co., Buffalo, N. Y.
Mayo & Hix, So. Boston, Mass.
S. G. Otis, Hallowell, Maine.
Sagadahoc Fertilizer Co., Bowdoinham, Me.
Standard Fertilizer Co., Boston, Mass.
J. A. Tucker & Co., Boston, Mass.

All the other companies mentioned in connection with the fertilizers sampled have failed, either through misunderstanding or neglect, to attend to this matter.

The object of this provision of the law is that the Station may be kept informed as to the fertilizers sold in the State, without the otherwise attendant trouble and uncertainty, and it is highly desirable that it shall be more strictly observed, or if necessary, enforced, in the future.

In all cases three samples of each brand have not been secured. In general this has been owing to the following causes, viz.: Sale of the fertilizer at but very few points; and finding only the goods held over from last year's sales in the hands of nearly all the agents visited.

SELECTION OF SAMPLES.

The samples for this year (1889) were selected by Mr. S. H. T. Hayes, an agent of the Station who acted under instructions which it is believed were faithfully and accurately observed.

In nearly all instances the samples were drawn from four packages, mostly 100-pound bags, so that in those cases where three samples were taken they represent twelve packages. As these packages were chosen by the Station representative from three separate lots of fertilizers at different times and in

different places, there seems to be little chance that the average composition of the samples analyzed is materially unlike the average of the goods offered for sale. This statement receives support from the fact that there are seldom any important variations in the composition and valuation of the three samples, and moreover the results of one year's inspection are generally practically in accord with those of other years, which would not be the case if the system of taking samples was inadequate to accomplish the desired purpose.

METHODS OF ANALYSIS.

Through the efforts of the Association of Official Agricultural Chemists uniform methods of fertilizer analysis are in use by experiment stations and official chemists, these methods being such as have been found by severe and extended tests to be reliable. The results of our best laboratories are now found to be in accord within the ordinary limits of error, a condition of things which is a great improvement over former years, and which is highly beneficial to all parties concerned.

THE TRADE VALUES OF FERTILIZERS FOR 1889.

The trade values given below which are used by this Station are those "agreed upon by the experiment stations of Massachusetts, New Jersey, Pennsylvania and Connecticut for use in their respective states during 1889. The valuations obtained by use of the following figures will be found to agree fairly with the *average retail price* at the large markets of standard raw materials such as:"

Sulphate of Ammonia,	Azotin,
Nitrate of Soda,	Ammonite,
Dried Blood,	Dry Ground Fish,
Muriate of Potash,	Bone or Tankage,
Sulphate of Potash,	Ground So. Carolina Rock,

Plain Superphosphates.

	Cts. per lb.
Nitrogen in ammonia salts	19
nitrates	17
Organic nitrogen in dry and fine ground fish, meat and blood	19
in cotton seed meal and castor-pomace	15
in fine bone and tankage	16½
in fine medium bone and tankage	13
in medium bone and tankage	10½
in coarser bone and tankage	8½
in hair, horn shavings and coarse fish scrap	8

	Cts. Per lb.
Phosphoric acid, soluble in water	8
in ammonium citrate	7½
in dry ground fish, fine bone and tankage	7
in fine-medium bone and tankage	6
in medium bone and tankage	5
in coarser bone and tankage	4
in fine ground rock phosphate	2
Potash as high-grade Sulphate and in forms free from Muriate (or Chlorides)	6
as kainite	4½
as muriate	4½

"These trade values are the average prices at which in the six months preceeding March the respective ingredients could be bought at retail for cash in our large markets, Boston, New York and Philadelphia, in the raw materials which are the regular source of supply. They also correspond to the average wholesale prices for the six months ending March 1st, plus about 20 per cent. in case of goods for which we have wholesale quotations."

These trade values which are based upon data collected in other states are adopted for Maine partly because of our easy access to the Boston market, the prices of which control our own markets, and partly because there is too little trade in raw materials in this State to allow any safe calculation of retail prices.

THE VALUATION OF SUPERPHOSPHATES AND MIXED GOODS.

These trade values are applied to the valuation of Superphosphates and all mixed goods, as follows:

It is assumed that the organic nitrogen of these goods has for its source such materials as dried blood, ground fish, or nitrogenous substances of equally good quality, unless a special examination of some particular brand shows that inferior material like leather has been used. Organic nitrogen in mixed goods will therefore be valued at nineteen cents per pound. The nitrogen present in nitrates and ammonia salts will be reckoned at seventeen and nineteen cents respectively.

The insoluble phosphoric acid of mixed fertilizers is considered as coming entirely from bone, and not from South Carolina rock, and is reckoned at three cents per pound.

The potash is valued at the price of that ingredient in kainite and the muriate, unless the chlorine present in the fertilizer is not sufficient to combine with it, in which case the excess of potash is reckoned at the price of the sulphate.

The valuation of a fertilizer is obtained by multiplying the percentages of the several ingredients by twenty (which gives the pounds per ton), and these products by the prices per pound, and the sum of the several final products is the market value of the fertilizing ingredients in one ton. For instance the "station valuation" of the Allen Fertilizer No. 437 is obtained as follows:

2.17 per cent.	Nitrogen	equal 43.4 lbs. per ton	@ 19cts.....	$8.25
4.64 "	Sol. phos. acid	" 92.8 " " "	@ 8cts.....	7.42
1.72 "	Rev. " "	" 34.4 " " "	@ 7½cts.....	2.58
2.29 "	Insol. " "	" 45.8 " " "	@ 3cts.....	1.37
5.00 "	Potash	" 100.0 " " "	@ 4½cts.....	4.50
Valuation				$24.12

CHARACTER OF THE FERTILIZERS SOLD IN MAINE.

Reference to the accompanying tables of analysis shows that the fertilizer trade in this State is confined almost entirely to nitrogenous superphosphates, i. e., fertilizers containing nitrogen, phosphoric acid and potash, the phosphoric acid being rendered largely available through the use of sulphuric acid. A few brands are sold, which are especially recommended as seeding down fertilizers, in which quite a large proportion of the phosphoric acid is combined in the raw or insoluble forms. It is worthy of remark that the commercial fertilizers sold in this State are in general of good quality and worthy the confidence of consumers.

HOME-MIXED FERTILIZERS.

The mixing of fertilizers on the farm through the use of chemicals and raw materials does not seem to have been undertaken to any extent by Maine farmers, although it is clearly shown that intelligent farmers of other states, Connecticut for instance, are finding it profitable to adopt this method of obtaining commercial manures. During the years 1887 and 1888 the Connecticut Experiment Station examined twenty-one fertilizers mixed by farmers from chemicals purchased by themselves, and the analyses show:

1. These home mixtures compared favorably in composition with the best factory made fertilizers.

2. The home mixtures had a satisfactory mechanical condition.

3. The ingredients of the home mixtures cost the consumers on an average from 20-25 per cent. less than if purchased in factory made fertilizers, after allowing $3.00 per ton for cost of mixing.

It is not claimed that all farmers would find it profitable to mix their own fertilizers from chemicals, but it is believed that there are many farmers in the State so situated with reference to markets and transportation that they could buy and mix chemicals with profit. This could be better done, perhaps, by an association of farmers, so that by the purchase and transportation of large lots at one time, a saving could be made in prices and freights.

If any farmer or association of farmers is disposed to give this matter a trial, the Station will advise, whenever desired, as to the proper selection of materials, formulas for mixing, etc.

THE ACCOMPANYING TABLES SHOWING ANALYSES AND VALUATIONS.

The talular statements, which are made in this connection, give the composition and approximate money value of the fertilizers sampled. The tables on the left hand pages show the history of the samples, and those on the right hand pages, the results of the laboratory examinations.

Four of the columns of figures it is especially important to notice, viz., those giving the percentages of *nitrogen*, *available phosphoric acid*, and *potash*, and the *station valuation*. In the case of those brands for which the manufacturers claim especial value as "seeding down" fertilizers the amount of *insoluble phosphoric acid* is generally so large as also to be a matter of importance.

It is to be noticed that the guarantees and selling prices are not mentioned as has been the case in previous reports of the Station. These are omitted in this report for several reasons:

1. It is desirable to make the tables of analyses as simple and as easy to consult as possible.

2. Not what a fertilizer is guaranted to contain, but what it actually does contain is the matter of chief importance to the farmer, and the latter rather than the former is what the station analyses show. Besides, the guarantees which manufacturers print have such wide limits in many cases as to detract somewhat from their value as a guide to purchasers.

3. Selling prices vary greatly in different localities. Those of his own, and not of other localities, are what concern the purchaser, and if he consults the Station valuations at all it is to compare them with the prices which are actually quoted to him. If the price of a particular fertilizer was uniform throughout the State its comparison with the valuation might be made in the Station report once for all, but a comparison for Bangor may have no value for some point in Aroostook Co.

SPECIAL MENTION OF CERTAIN FERTILIZERS.

No. 481 is a fertilizer somewhat unusual in character for our markets, consisting of equal parts of cotton-seed meal and the ash of cotton-seed hulls, it is claimed. The ingredients, as might be expected, are largely available. The special characteristic of this fertilizer is its large percentage of potash (9.19 per cent.), so that it would be especially valuable for those needing a potash manure.

Gile's Home-made Superphosphate No. 500 is manufactured according to the following recipe:

"Take one ton of bone meal and five barrels of hard wood ashes, mix thoroughly in a water-tight tank and fill with water, all that will soak in. Let this mixture stand at least *two weeks* and keep *wet*. DON'T LET IT DRY. At the end of two weeks, mix the above with twice its bulk of muck and loam, in equal parts. Mix very thoroughly by machinery and pile in a heap to dry. *Do not let it dry enough to heat, and keep it from the air as much as possible.*"

This fertilizer is sold at the factory for $20 per ton, cash. The station valuation is $8.24. As the station valuation is generally about 20 per cent less than the selling price of the best factory made superphosphates, the price of the article in question should be about $10 per ton.

The estimate of a fair price can be reached in another way. One ton of bone meal and not far from fifteen bushels (600 lbs.) of hard wood ashes are thoroughly saturated with water, and to this quantity of wet material is added twice its bulk of equal parts of loam and muck. We have therefore,—

	Weight.		
Bone meal	2000 lbs.,	costing	$35.00*
Ashes, five barrels, (15 bu.)	600 "	"	3.75
Muck, loam and water	6500 "		
	9100 lbs.,		$38.75
Selling price of 9000 lbs., (4½ tons) at $20. per ton			90.00
Difference between selling price of bone and ashes and fertilizer,			$51.25

It is assumed that the muck, loam and water added will weigh two and one half times the original bone and ashes, which is certainly a low estimate. One ton of bone and five barrels of ashes are therefore converted into four and one-half tons of fertilizer for which the consumers are asked to pay $90. Any farmer can buy the bone and ashes for not more than $38.75

* This price should secure the best quality of ground bone.

certainly, or at Mr. Gile's price* for bone, for $33.75, and the question which arises is, can the farmer afford to pay the difference of from $50. to $56. for having the materials treated and mixed?

For full explanations of terms, method of valuation, etc., reference is made to the report of this station for 1888, pages 27 to 36. *Preserve this report for use in the spring of 1890.*

* Mr. Gile offers to sell ground bone at his mill for $30, per ton.

Tables showing Analyses and Valuations of Fertilizers offered for Sale in 1889.

Analyses by J. M. BARTLETT and L. H. MERRILL.

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
437	Allen Fertilizer	American Manufacturing Co., Boston, Mass.	Saco	437
447	Americus Amm. Bone Superphosphate	Williams & Clark Co., New York, N. Y.	Bowdoinham	447
455	" "	" " " " "	Bangor	455
478	" "	" " " " "	Foxcroft	478
404	Ammoniated Bone Superphosphate	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Orono	404
420	" "	" " " " "	Lewiston	420
466	" "	" " " " "	Houlton	466
412	Bay State Fertilizer	Clark's Cove Guano Co., New Bedford, Mass.	Pittsfield	412
418	" "	" " " "	Bangor	418
428	" "	" " " "	Norway	428

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	% Reverted.	% Insoluble.	% Total.	% Available.	% Potash.	Station Valuation. $	Station Number.
437	Allen Fertilizer	20.47	**2.17**	4 64	1.72	2.29	8.65	**6.36**	**5.00**	**24.12**	437
447	Americus Ammoniated Bone Superphosphate	10.31	2.61	8.74	1.83	.42	10.99	10.57	3.12	30.49	447
455	" " " "	8.70	2.71	9.70	1.28	.56	11.54	10.98	2.74	32.74	455
478	" " " "	8.63	2.71	9.62	1.69	.40	11.71	11.31	2.69	31 59	478
	Average	9.21	**2.67**	9.35	1.60	.46	11.41	**10.95**	**2.85**	**31.61**	
404	Ammoniated Bone Superphosphate	12.86	2.84	7.74	1.87	1.68	11.29	9.61	1.47	28.29	404
420	" " "	11.38	2.96	7.25	3.77	.51	11.53	11.02	1.29	29.90	420
466	" " "	12.94	2.12	9.11	1.86	.99	11.96	10.97	3.54	29.21	466
	Average	12.39	**2.64**	8.03	2.50	1.06	11.59	**10.53**	**2.10**	**29.13**	
412	Bay State Fertilizer	10.70	2.91	6.58	4.17	1.92	12.67	10.75	2.34	30.97	412
418	" "	10.66	2 87	5.88	4.61	1.94	12.43	10.49	2.46	30.47	418
428	" "	10 44	2.77	6.09	4.10	2.35	12.54	10.19	2.42	29.87	428
	Average	10.60	**2.85**	6.18	4.29	2.17	12.54	**10.47**	**2.41**	**30.43**	

The *available* phosphoric acid is the sum of the *soluble* and *reverted*.

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
425	Bay State Superphosphate	J. A. Tucker & Co., Boston, Mass.	South Paris	425
429	" "	" " " "	Oxford	429
501	" "	" " " "	New Gloucester	501
454	B. D. Sea Fowl Guano	Bradley Fertilizer Co., Boston, Mass.	Bangor	454
496	" " "	" " "	Winthrop	496
502	Bowker's Ammoniated Dissolved Bone	Bowker Fertilizer Co., Boston, Mass.	Monmouth	502
430	Bowker's Hill and Drill Phosphate	Bowker Fertilizer Co., Boston, Mass.	Oxford	430
448	" " "	" " "	Bowdoinham	448
485	" " "	" " "	Bath	485

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	% Reverted.	% Insoluble.	% Total.	% Available.	% Potash.	$ Station Valuation.	Station Number.
425	Bay State Superphosphate	15.02	2.72	6.49	2.13	2.42	11.04	8.62	2.24	27.37	425
429	" " "	15.54	2.54	5.48	2.81	2 38	10 67	8.29	2.22	26.06	429
501	" " "	14.97	2.78	5.71	2.64	2.26	10 61	8 35	2.13	27.94	501
	Average	15.17	**2.68**	5.89	2.53	2.35	10.77	**8.42**	**2.20**	**27.12**	
454	B. D. Sea Fowl Guano	14.03	2.43	7.96	2.31	2.80	13.07	10.27	1.76	28.61	454
496	" " " "	13.01	2.40	7.68	2.97	2 33	12.98	10.65	1.87	28.95	496
	Average	13.52	**2.42**	7.82	2 61	2.56	13.02	**10.46**	**1.81**	**28.78**	
502	Bowker's Ammoniated Dissolved Bone	10.50	**2.36**	7.29	2.32	4.09	13.70	**9.61**	**2 08**	**28.32**	502
430	Bowker's Hill and Drill Phosphate	10.14	3.31	6.72	2 48	3 39	12.59	9.20	1.14	29.93	430
448	" "	12.07	3.03	7.54	2.27	2.87	12.68	9.81	1.95	30.18	448
485	" "	9.35	2.77	6.61	1.89	5.30	13.80	8.50	2.43	29.13	485
	Average	10.52	**3.03**	6.96	2.21	3 85	13.02	**9.17**	**1.84**	**29.74**	

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
467	Bowker's Potato Phosphate	Bowker Fertilizer Co., Boston, Mass	Houlton	467
410	Bradley's Eureka Seeding Down Fertilizer	Bradley Fertilizer Co., Boston, Mass	Fairfield	410
413	" " " "	" " "	Bangor	413
474	" " " "	" " "	Foxcroft	474
414	Bradley's Potato Manure	Bradley Fertilizer Co., Boston, Mass	Bangor	414
438	" " "	" " "	Saco	438
460	" " "	" " "	Houlton	461
415	Bradley's X. L. Superphosphate	Bradley Fertilizer Co., Boston, Mass	Bangor	415
422	" " "	" " "	Mechanic Falls	422
460	" " "	" " "	Houlton	460

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	Phosphoric Acid. % Reverted.	Phosphoric Acid. % Insoluble.	Phosphoric Acid. % Total.	Phosphoric Acid. % Available.	% Potash.	Station Valuation. $	Station Number.
467	Bowker's Potato Phosphate	9.88	**2.75**	5.42	1.76	6.52	13.70	**7.18**	**3.79**	**28.88**	467
410	Bradley's Eureka Seeding Down Fertilizer	9.63	1.91	4.32	3.15	4.51	11.98	7.47	2.57	23.91	410
413	" " " "	7 98	1.91	3.54	3.49	4.45	11.48	7.03	3.04	23.56	413
474	" " " "	7.36	1.86	3.35	2.16	5.85	11.36	5.51	2.90	21.71	474
	Average	8.32	**1.89**	3.74	2.93	4.93	11.60	**6.67**	**2.83**	**23.06**	
414	Bradley's Potato Manure	10.98	2.96	5.56	2.16	1.96	9.68	7.72	5.69	29.48	414
438	" "	11.91	2.91	6.04	2.33	1.93	10.30	8.37	5.74	30.54	438
461	" "	13.48	2.73	6.28	1.53	2.35	10.16	7.81	5.08	28.57	461
	Average	12.12	**2.86**	5.96	2.00	2.08	10.04	**7.96**	**5.50**	**29.53**	
415	Bradley's X. L. Superphosphate	14.96	2.56	7.91	1.93	2.17	12.01	9.84	1.82	29.17	415
422	" " "	13.86	2.59	8.03	2.22	2.10	12.35	10.25	2.20	28.26	422
460	" " "	15.86	2.61	8.57	1.24	2.02	11.83	9.81	1.90	28.27	460
	Average	14 ·89	**2.58**	8.17	1.79	2.09	12.06	**9.96**	**1.97**	**28.56**	

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
450	Cleveland Superphosphate	Cleveland Dryer Co., Boston, Mass	Gardiner	450
464	" "	" " "	Houlton	464
451	Cleveland Potato Phosphate	Cleveland Dryer Co., Boston, Mass	Gardiner	451
465	Common Sense Fertilizer No. 2	Common Sense Fertilizer Co., Boston, Mass	Ludlow	465
481	Cotton Seed Meal and Ash of Hulls		Rockland	481
417	Cumberland Bone Superphosphate	Cumberland Bone Co., Portland, Me	Bangor	417
423	" " "	" " "	Mechanic Falls	423
471	" " "	" " "	Lincoln	471

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	Phosphoric Acid. % Reverted.	Phosphoric Acid. % Insoluble.	Phosphoric Acid. % Total.	Phosphoric Acid. % Available.	% Potash.	Station $ Valuation.	Station Number.
450	Cleveland Superphosphate	14.22	4.08	8.00	2.02	1.52	11.54	10.02	2.55	34.53	450
464	" "	14.50	2.59	8.03	2.12	1.71	11.86	10.15	1.46	28.06	464
	Average	14.36	**3.33**	8.01	2.07	1.61	11.70	**10 08**	**2.00**	**31.29**	
451	Cleveland Potato Phosphate	11.48	**2.33**	5.99	2.52	4.21	12.72	**8.51**	**3 64**	**27.68**	451
465	Common Sense Fertilizer No. 2	9.80	**1.94**	......	5.49	5.79	11.28	**5.49**	**1.54**	**20.28**	465
481	Cotton Seed Meal and Ash of Hulls	4.13	**2.71**	.....	3.51	1.30	4.81	**3.51**	**9.19**	**27.38**	481
417	Cumberland Bone Superphosphate	11.24	2.19	6.36	6.17	2.80	15.33	12.53	2.18	31.24	417
423	" " "	12.03	2.35	6.68	6.69	2.03	15.40	13.37	1.96	32.53	423
471	" " "	11.30	2.61	6.78	5.49	2.60	14.87	12.27	2.34	32.48	471
		11.52	**2.38**	6.60	6.11	2.47	15 20	**12.72**	**2.16**	**32.08**	

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
416	Cumberland Seeding Down Fertilizer	Cumberland Bone Co., Portland. Me	Bangor	416
458	" " "	" " "	Houlton	458
473	" " "	" " "	Foxcroft	473
443	Dirigo Fertilizer	Sagadahoc Fertilizer Co., Bowdoinham. Me	Bowdoinham	443
489	" "	" " "	Oakland	489
493	" "	" " "	Winthrop	493
442	E. Frank Coe's Alkaline Bone	E. Frank Coe, New York, N. Y	Saco	442
441	E. F. Coe's High Grd. Amm. Bone Super	E. Frank Coe, New York, N. Y	Saco	441
456	Farrar's Superphosphate	F. S. Farrar & Co., Bangor. Me	Brewer	456
476	" "	" "	Foxcroft	476

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	% Revert-ed.	% Insolu-ble.	% Total.	% Availa-ble.	% Potash.	$ Station Valuation.	Station Number.
416	Cumberland Seeding Down Fertilizer	10.15	2.00	2.19	3.87	14.78	20.84	6.06	.30	25.91	416
458	" " "	8.87	1.52	1.92	3.11	19.14	24.17	5.03	.72	22.48	458
473	" " "	10.80	1.94	2.79	7.71	10.29	20 79	10.50	.23	29.65	473
	Average	9.94	**1.82**	2.30	4.89	**14.73**	21.93	**7.19**	**.41**	**26.01**	
443	Dirigo Fertilizer	9.41	3.15		4.31	7.91	12.22	4.31	2.52	25.46	443
489	" "	8.45	2.98	.61	2.02	7.07	9.70	2.63	4.47	23.59	489
493	" "	9.70	3.31	.90	3.15	5.56	9.61	4.05	3.55	25.29	493
	Average	9.18	**3.14**	.50	3.16	**6.84**	10.51	**3.66**	**3.51**	**24.78**	
442	E. Frank Coe's Alkaline Bone	10.14	**.98**	8.25	2.22	2.80	13.27	**10.47**	**1.90**	**23.97**	442
441	E. F. Coe's High Grade Ammo. Bone Superphosphate	9.28	**2.34**	8.79	1.46	1.56	11.81	**10.25**	**2.19**	**28.55**	441
456	Farrar's Superphosphate	14.00	2.71	7.59	1.97	2.87	12.43	9.56	2.06	28.84	456
476	" "	13.82	2.28	7.65	2.31	2.85	12.81	9.96	1.98	27.73	476
	Average	13.91	**2.49**	7.62	2.14	2.86	12.62	**9.76**	**2.02**	**28.28**	

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
500	Gile's Home-made Superphosphate	F. H. Gile, Alfred, Me	Alfred	500
411	Gloucester Fish and Potash	Bowker Fertilizer Co., Boston, Mass	Fairfield	411
469	" " "	" " "	Houlton	469
486	" " "	" " "	Bath	486
483	Otis Superphosphate	S. G. Otis, Hallowell, Me	Damariscotta	483
487	" "	" "	Hallowell	487
403	Potato, Hop and Tobacco Phosphate	Crocker Fertilizer & Chemical Co., Buffalo, N. Y.	Orono	403
421	" " " "	" " " "	Lewiston	421
427	" " " "	" " " "	So. Paris	427

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	% Reverted.	% Insoluble.	% Total.	% Available.	% Potash.	Station Valuation. $	Station Number.
500	Gile's Home-made Superphosphate	20.97	.81		2.04	2.94	4.98	2.04	.38	8.24	500
411	Gloucester Fish and Potash	10.92	1.77	6.72	2.41	5.90	15.03	9.13	2.03	26.46	411
469	" " "	13.82	1.93	8.14	1.19	3.36	12.69	9.33	.96	24.85	469
486	" " "	11.83	2.17	6.28	2.39	6.27	14.94	8.67	1.89	27.35	486
	Average	12.19	**1.95**	7.04	1.99	5.17	14.22	**9.04**	**1.62**	**26.22**	
483	Otis' Superphosphate	13.17	2.64	8.56	1.92	1.42	11.90	10.48	1.81	29.09	483
487	" "	13.08	2.87	7.68	2.19	1.96	11.83	9.87	2.32	29.67	487
	Average	13.12	**2.75**	8.12	2.05	1.69	11.86	**10.17**	**2.06**	**29.38**	
403	Potato, Hop and Tobacco Phosphate	13.79	1.75	8.96	1.72	1.01	11.69	10.68	3.93	27.71	403
421	" " " "	12.68	1.98	8.96	2.42	.36	11.74	11.38	3.85	28.97	421
427	" " " "	12.15	2.01	9.27	1.95	.97	12.19	11.22	3.97	29.54	427
	Average	12.87	**1.91**	9.06	2.03	.78	11.87	**11.09**	**3.91**	**28.74**	

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
446	Potato Phosphate	Williams & Clark Co., New York, N. Y.	Bowdoinham	446
452	" "	" " " " "	Hallowell	452
499	" "	" " " " "	Portland	499
490	Quinnipiac Grass Fertilizer	Quinnipiac Fertilizer Co., New London, Conn	Winthrop	490
498	" " "	" " " " "	Portland	498
432	Quinnipiac Phosphate	Quinnipiac Fertilizer Co., New London, Conn	Auburn	432
440	" "	" " " " "	Saco	440
492	" "	" " " " "	Winthrop	492

FERTILIZER ANALYSES.

Station No.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	% Revert-ed.	% Insolu-ble.	% Total.	% Avail-able	% Potash.	$ Station Valuation	Station No.
446	Potato Phosphate	12.18	2.84	6.41	1.38	.47	8.26	7.79	6.28	30.66	446
452	" "	15.79	2.68	6.40	1.07	.46	7.93	7.47	5.78	27.50	452
499	" "	15.10	2.64	6.52	1.18	.32	8.02	7.70	5.45	27.32	499
	Average	14.35	**2.72**	6.44	1.21	.41	8.07	**7.65**	**5.83**	**28.49**	
490	Quinnipiac Phosphate	21.22	3.15	3.01	3.91	2.34	9.29	6.95	5.67	28.91	490
498	" "	20.44	3.73	2.49	4.58	2.33	9.40	7.07	5.59	31.12	498
	Average	20.83	**3.44**	2.75	4.26	2.33	9.34	**7.01**	**5.63**	**30.01**	
432	Quinnipiac Phosphate	18.92	2.66	4.25	6.30	2.50	13.05	10.55	1.40	29.07	432
440	" "	17.94	2.81	4.55	6.98	2.61	14.14	11.53	1.48	31.33	440
492	" "	18.33	2.61	4.54	6.87	2.71	14.12	11.41	1.58	30.54	492
	Average	18.39	**2.69**	4.44	6.71	2.60	13.77	**11.16**	**1.48**	**30.31**	

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at	Station Number.
433	Quinnipiac Potato Manure	Quinnipiac Fertilizer Co., New London, Conn	Auburn	433
439	" " "	" " " " "	Saco	439
491	" " "	" " " " "	Winthrop	491
444	Sagadahoc Superphosphate	Sagadahoc Fertilizer Co., Bowdoinham, Me	Bowdoinham	444
453	" "	" " " " "	Hallowell	453
494	" "	" " " " "	Winthrop	494
449	Soluble Pacific Guano	Soluble Pacific Guano Co., Boston, Mass	Gardiner	449
457	" " "	" " " " " "	Brewer	457
472	" " "	" " " " " "	Dover	472
480	Special Potato Fertilizer	La Page Manufacturing Co., Boston, Mass	Rockland	480

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Solu-ble.	% Revert-ed.	% Insol-uble.	% Total.	% Avail-able.	% Potash.	Station Valuation. $	Station Number.
433	Quinnipiac Potato Manure	21.50	2.86	3.62	3.08	1.46	8.16	6 70	4.78	26.46	433
439	" " "	21.61	2.94	3.71	3.30	1.11	8.12	7.01	4.94	27.19	439
491	" " "	21.96	2.89	3.84	2.84	1 47	8.15	6.68	5.03	26.79	491
	Average	21.69	**2.89**	3.72	3.07	1 34	8.14	**6.79**	**4.91**	**26.81**	
444	Sagadahoc Superphosphate	15.63	2.82	6.08	2.71	2 02	10.81	8.79	2.42	27 83	444
453	" "	15 32	2.87	6.06	2.37	1.28	9.71	8 43	4.53	29.72	453
494	" "	11.10	2.27	7.51	1.85	1.10	10.46	9.36	2.45	26.79	494
	Average	14.01	**2.65**	6.55	2.31	1.46	10.32	**8.86**	**3.13**	**28.11**	
449	Soluble Pacific Guano	12.80	2.91	6.23	1.92	2.70	10 85	8.15	2.46	27.74	449
457	" " "	14.45	2.99	7.37	1.70	1.88	10.95	9.07	2.91	29.33	457
472	" " "	11.97	2.84	7.37	2.05	2.11	11.53	9.42	2.87	29.50	472
	Average	13.07	**2.91**	6.99	1.89	2.23	11.11	**8.88**	**2.74**	**28.85**	
480	Special Potato Fertilizer	10.29	**2.84**	2.79	2.35	3.70	8.84	**5.32**	**5 14**	**25.63**	480

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
462	Standard Fertilizer	Standard Fertilizer Co., Boston, Mass	Houlton	462
479	" "	" " " "	Rockland	479
488	" "	" " " "	Oakland	488
434	Standard Superphosphate	Standard Fertilizer Co., Boston, Mass	Auburn	434
495	" "	" " " "	Winthrop	495
408	Stockbridge's Corn and Grain Manure	Bowker Fertilizer Co., Boston, Mass	Waterville	408
435	" " " " "	" " "	Saco	435
484	" " " " "	" " "	Bath	484
407	Stockbridge's Grass Top Dressing	Bowker Fertilizer Co., Boston, Mass	Waterville	407

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Soluble.	% Revert-ed.	% Insolu-ble.	% Total.	% Avail-able	% Potash.	Station Valuation $	Station No.
462	Standard Fertilizer	13.55	1.95	7.93	1.19	2.33	11.45	9.12	2.07	25.06	462
479	"	13.68	2.05	7.28	2.26	2.47	12.01	9.54	2.40	26.47	479
488	"	13.58	2.10	7.57	1.75	2.17	11.49	9.32	2.06	25.87	488
	Average	13.60	**2.03**	7.59	1.73	2.32	11.64	**9.32**	**2.17**	**25.80**	
495	Standard Superphosphate	13.12	2.50	7.77	1.66	2.58	12.01	9.43	2.23	27.98	495
434	"	14.14	2.24	7.70	2.29	2.24	12.23	9.99	2.00	27.41	434
	Average	13.63	**2.37**	7.73	1.97	2.41	12.12	**9.71**	**2.11**	**27.66**	
408	Stockbridge's Corn and Grain Manure	9.68	3.26	5.95	3.05	3.19	12.19	9.00	4.28	31.85	408
435	" " " " "	10.77	3.19	6.43	2.05	2.89	11.37	8.48	3.90	30.29	435
484	" " " " "	10.40	3.22	5.96	2.34	3.84	12.14	8.30	3.99	30.86	484
	Average	13.61	**3.22**	6.11	2.48	3.30	11.90	**8.59**	**4 05**	**31.00**	
407	Stockbridge's Grass Top Dressing	7.17	**4.85**	2.87	2.44	5.13	10.41	**5.31**	**6.21**	**34.08**	407

FERTILIZER SAMPLES.

Station Number.	Brand.	Manufacturer.	Sampled at.	Station Number.
405	Stockbridge's Potato and Veg. Manure....	Bowker Fertilizer Co., Boston, Mass............	Waterville...........	405
436	" " " " "	" " "	Saco.................	436
468	" " " " "	" " "	Houlton.........	468
406	Stockbridge's Seeding Down Fertilizer.. .	Bowker Fertilizer Co., Boston, Mass............	Waterville.	406
497	" " " "	" " "	Monmouth	497
419	Unicorn Ammoniated Superphosphate....	Williams & Clark Co., New York, N. Y.........	Bangor...............	419
482	" " "	" " " "	Damariscotta.........	482
463	Wilkinson's Ammoniated Superphosphate	Wilkinson & Co., New York, N. Y...............	Houlton.............	463
475	" " "	" " " "	Dover...............	475

FERTILIZER ANALYSES.

Station Number.	Brand.	% Moisture.	% Nitrogen.	Phosphoric Acid. % Solu-ble.	% Revert-ed.	% Insol-uble.	% Total.	% Avail-able.	% Potash.	$ Station Valuation.	Station Number.
405	Stockbridge's Potato and Vegetable Manure	8.78	3.50	6.04	2.48	3.03	11.55	8.52	6.48	34.16	405
436	" " " "	9.89	2.83	6.47	2.59	2.84	11.90	9.06	5.29	31.44	436
468	" " " "	14.57	3.43	7.50	2.05	1.55	11.10	9.55	3.74	30.92	468
	Average	11.08	**3.25**	6.67	2.37	2.47	11.51	**9.04**	**5.17**	**32.17**	
406	Stockbridge's Seeding Down Fertilzer	8.23	3.06	5.59	1.56	5.97	13.12	7.15	4.04	29.82	406
497	" " "	9.62	3.03	5.68	1.52	5.81	13.01	7.20	2.92	28.82	497
	Average	8.92	**3.04**	5.63	1.54	5.89	13.06	**7.17**	**3 45**	**29.34**	
419	Unicorn Ammoniated Superphosphate	12 77	2.11	3.77	4.86	3.88	12 51	8.63	2.66	25.90	419
482	" " "	9.16	2.13	3.77	4.41	4.38	12.56	8.18	2.82	25.91	482
	Average	10.26	**2.12**	3.77	4.63	4.13	12.53	**8.40**	**2.74**	**25.90**	
463	Wilkinson's Ammoniated Superphosphate	16.61	2.24	5.16	1.52	1.11	7.79	6.68	3.91	23.15	463
475	" " "	16.92	1.03	5 69	2.52	.95	9.16	8 21	3.11	20.16	475
	Average	16.73	**1.63**	5.42	2.02	1.03	8.47	**7 44**	**3.51**	**21.65**	

THE QUALITY OF THE NITROGENOUS MATERIAL IN THE SUPERPHOSPHATES SOLD IN MAINE.

The possible varieties of nitrogenous material available for use in the manufacture of superphosphates are numerous. Nitrate of soda, sulphate of ammonia, dried blood, dried and ground flesh of animals and fishes, cotton-seed meal, ground horn and hoof, hair and wool waste and prepared leather, are some of the substances, which in various forms and under various names, supply nitrogen to our mixed fertilizers. These materials vary greatly in value, both commercially and as plant food. This fact has been the cause of uncertainty in the valuation of the nitrogen in superphosphates.

Reliable methods of analysis can be used to separate the organic nitrogen (nitrogen coming from animal or vegetable matter) from that existing as nitric acid or ammonia, the latter forms being readily available plant food. But it has not been so easy to ascertain the quality of the organic nitrogen, whether from dried blood or horn, from meat or leather. It is has been darkly hinted now and then that a great deal of inferior nitrogenous material is used by the manufacturers of fertilizers, though no proof of this has been furnished to the public.

Experiment stations have assumed that the organic nitrogen of mixed fertilizers is supplied in the best forms, and have valued it accordingly, but it has been recognized, at the same time, that some way of detecting inferior forms is extremely desirable. The method for doing this which has received most attention is based upon the different degrees of solubility of organic nitrogen compounds in a pepsin solution. The nitrogen of dried blood, dried flesh, cotton-seed meal and similar high grade nitrogenous materials is very largely dissolved by digestion in a pepsin solution, while that of horn, hoof and leather is much less affected by this treatment.

In support of this statement there is given below the results of experiments conducted in three different laboratories for the purpose of testing the value of this method.* With regard to most of the materials used, these results are practically in accord.

* The method of treating the substances was briefly as follows: The pepsin solution was made by dissolving 5 grams of scale pepsin in 1000 c. c. of .2 per cent. hydrocholic acid. Two grams of the substance were digested for 12 hours on each of two consecutive days with 200 c. c. of this solution, at a temperature of 40 degrees C. During the time of digestion 2 c. c. of a ten per cent. solution of hydrocholic acid were added at regular intevals until the digestive fluid contained 1 per cent. of the acid.

SOLUBILITY OF CERTAIN NITROGENOUS MATERIALS IN PEPSIN SOLUTION.

MATERIALS USED.	Per Cent. of Total Nitrogen Dissolved as found by Shepard & Chazal.	Conn. Expt. Sta.	Maine Expt. Sta.
Dried Blood	99.8, 78.6 } 98.2	96.8, 97.9 } 97.3	97.3, 93.3, 97.6, 95.1 } 95.8
Cotton Seed Meal	83.2, 85.7, 83.1 } 84.0	92.7	
Ground Bone		52. to 99.* av. 78.	68.3
Dried Flesh	93.3	78.7, 85.4, 77.5 } 80.5	75.7, 75.4, 78.4 } 76.5
Dried Fish		58. to 72.† av. 66.	
Fish Scrap	88.6, 84.6 } 86.6		59.2, 82.6 } 70.9
Tankage	61.3		58.0, 48.6 } 53.3
Wool Waste		4.8	
Leather	37.8	25.4, 35.9, 33.3 } 34 9	26.5, 7.7 } 17.1
Horn and Hoof Meal		7.2, 22.4, 28.2 } 19.3	25.6

* 20 samples. † 7 samples.

The degree of solubility for cheap and inferior "ammoniates" such as horn, hoof, leather and wool waste is seen to vary from 4.8 per cent. to 37.8 per cent., while in the case of dried blood, cotton-seed meal, dried and ground flesh, dried fish, fish scrap and ground bone the average percentages of the different trials range from 70.9 per cent. to 97.3 per cent.

It is shown by the Conn. Experiment Station* that mixing with these ammoniates mineral compounds of the kind and in the quantity that would be found accompanying them in superphosphates does not materially change their solubility in a pepsin solution, consequently it is fair to conclude that the solubility in a pepsin solution of the organic nitrogen of a superphosphate will show whether this ingredient is furnished largely in an inferior form.

In accordance with this idea, Mr. Merrill has tested the solubility of the organic nitrogen in the superphosphates inspected by this Station for 1889.

His methods were as follows:

The sample taken to represent a brand of superphosphate was made up so as to represent the average of all the samples of that brand selected this season. This was done, for instance in the case of the Bay State Fertilizer by weighing out equal quantities of Nos. 412, 418 and 428, and thoroughly mixing them in a mortar. One gram of substance was thoroughly leached with water and then submitted to the action of a pepsin solution in accordance with the method previously given. The insoluble nitrogen of the residue was then determined.

The percentages of organic nitrogen given are the total nitrogen minus the nitrogen as nitric acid and ammonia. The tables which follow explain themselves.

* Report Conn. Experiment Station, 1885, pp. 120-121.

Brand.	Per Cent. of Nitrogen in Fertilizer.				Solubility in Pepsin Solution.		Per cent. of Total Nitrogen Soluble in Water and Pepsin Solution.
	Nitrogen as Nitric Acid.	Nitrogen as Ammonia.	Organic Nitrogen.	Total Nitrogen.	Organic Nitrogen Soluble in Pepsin. Per cent. in Fertilizer.	Per cent. of Organic Nitrogen Soluble in Pepsin Solution.	
Allen's Fertilizer		.76	1.41	2.17	.73	51.8	68.7
Americus Ammoniated Bone Superphosphate		.91	1.80	2.71	1.27	70.6	80.4
Crocker's Ammoniated Bone Superphosphate			2.64	2.64	1.87	70.8	70.8
Bay State Fertilizer	.33	.83	1.69	2.85	1.28	75.7	85.6
Bay State Superphosphate		.25	2.43	2.68	1.46	60.0	63.8
B. D. Sea Fowl Guano	.10	.54	1.78	2.42	.86	48.3	62.0
Bowker's Hill and Drill Phosphate	.55		2.49	3.04	1.94	77.9	81.1
Bowker's Potato Phosphate	.54	.15	2.06	2.75	1.50	72.8	79.6
Bradley's Eureka Seeding Down Fertilizer			1.89	1.89	1.21	64.0	64.0
Bradley Potato Manure	.31		2.56	2.87	1.73	67.6	71.1
Bradley's X L Superphosphate	.21		2.38	2 59	1.76	74.0	76.1
Cleveland Potato Phosphate	.80		1.53	2.33	.58	37.9	59.2
Cleveland Superphosphate	.64	.16	2.54	3.34	1.87	73.6	79.9
Common Sense Fertilizer No. 2.	.37	.96	.61	1.94	.13	21.3	75.2
Cotton Seed Meal and Ash of Hulls			2.71	2.71	2.26	83.4	83.4
Cumberland Bone Superphosphate	.43	.20	1.75	2.38	1.34	76.6	82.8
Cumberland Seeding Down Fertilizer	.34	.40	1.08	1.82	.77	71.3	83.0
Dirigo Fertilizer			3.14	3.14	1.58	50.3	50.3
E. Frank Coe's Alkaline Bone			.98	.98	.67	68.4	68.4
Coe's High Grade Ammoniated Superphosphate		.76	1.58	2.34	1.14	72.8	81.2
Farrar's Superphosphate	.31		2.19	2.50	1.61	73.5	76.8

Brands.	Per Cent. of Nitrogen in Fertilizer. Nitrogen as Nitric Acid.	Nitrogen as Ammonia.	Organic Nitrogen.	Total Nitrogen.	Solubility in Pepsin Solution. Organic Nitrogen Soluble in Pepsin. Per cent. in Fertilizer.	Per cent. of Organic Nitrogen Soluble in Pepsin Solution.	Per cent. of Total Nitrogen Soluble in Water and Pepsin Solution.
Gloucester Fish and Potash.....		.14	1.82	1.96	1.38	75.8	77.6
Otis Superphosphate............		.16	2.60	2.76	1.72	66.2	68.1
Crocker's Potato, Hop and Tobacco Phosphate.........			1.91	1.91	1.26	66.0	66.0
Williams & Clark Potato Phosphate............... ..		.93	1.79	2.72	1.08	60.3	73.9
Quinnipiac Grass Fertilizer.....	.78	.42	2.24	3.44	1.14	50.9	68.0
Quinnipiac Phosphate...........		.47	2.22	2.69	1.12	50.4	59.1
Quinnipiac Potato Manure......		.55	2.32	2.87	1.05	45.3	55.8
Sagadohoc Superphosphate.....	.63	.42	1.60	2.65	.72	45.0	66.8
Soluble Pacific Guano..	.11	.24	2.56	2.91	1.77	69.1	72.8
LaPage Special Potato Fertilizer...................		.16	2.68	2.84	1.62	60.5	62.7
Standard Fertilizer............			2 03	2.03	1.42	70.0	70.0
Standard Superphosphate.......			2.37	2.37	1.45	61.2	61.2
Stockbridge's Corn and Grain Manure....	.93	.16	2.13	3.22	1.57	73.7	82.6
Stockbridge's Grass Top Dressing.....	3.15	.30	1.40	4.85	1.00	71.4	91.7
*Stockbridge's Potato and Vegetable Manure..........	.24	.81	2.08	3.13	1.43	68.8	79.2
Stockbridge's Seeding Down....	.60		2.45	3.05	1.88	76.7	81.3
Unicorn Amm. Superphosphate.	.20	.24	1.68	2.12	1.11	66.1	73.1
Wilkinson's Ammoniated Superphosphate............		.90	.74	1.64	.22	29.7	68.3

*Only two samples were used of this brand, 436 and 468.

In the thirty-nine brands tested the solubility of the organic nitrogenous material ranges from 21.3 per cent. to 83.4 per cent. In three cases the percentages are below 40 per cent., in three between 40 and 50 per cent., in four between 50 and 60 per cent., and in twenty-nine over 60 per cent. A solubility of less than 40 per cent. gives good grounds for suspecting the use of an inferior ammoniate. In fact, anything less than 50 per cent. is to be regarded as indicating the presence of organic material of a lower grade than dried blood, dried flesh and dried fish. At the same time a close grading of the quality of the nitrogenous matter of Superphosphates does not seem to be possible by this method.

SUGGESTIONS FOR BUYING FERTILIZERS.

1. It is safer to purchase brands of recognized good standing. New brands may be just as good or better than those longer on the market, but their quality should be carefully ascertained.

2. The composition of the fertilizers in the markets can be learned from a study of the Station reports of inspection. Compare the composition of the different brands which you have the chance to purchase and buy the one the value of which comes most largely from nitrogen, from phosphoric acid, or from potash, according to your needs. Your needs you can only know from experience.

3. If the station money valuation of two brands differs by considerable, other things being equal, buy the one having the higher valuation. Do not give too much weight to small differences in money valuation.

4. The dryness and mechanical condition of a fertilizer should be considered, especially if it is to be used in a seed drill.

CATTLE FOODS.

ANALYSES OF HAYS FROM VARIOUS GRASSES.

For several years samples have been collected of the various grasses and other fodder plants growing on the College Farm, which have been analyzed, and some have been submitted to digestion tests. This work has been continued with additional samples collected in 1888. The analyses of six hays from five different species of grasses and one clover are given below, all from the crop of 1888.

The samples were all cut during the first few days of July while the plants were in full bloom, and were carefully dried and stored, so that the analyses represent the hays in their best possible condition.

The terms used in stating the analysis of a fodder, such as "*protein*," "*fiber*," etc., are explained in the report of this station for 1888, pages 83-85, and in the same connection are given on pages 81-83 some general considerations bearing upon the value and need of a wider knowledge of the composition of our fodder plants.

TABLE OF FODDER ANALYSES.

Station Number.	DESCRIPTION OF SAMPLES, *Crop of 1888.*	In 100 parts of air-dry substance.						In 100 parts of water-free substance.				
		% Water.	% Ash.	% Protein Nx6.25.	% Fiber.	% Nitrogen-free extractive matter.	% Fat.	% Ash.	% Protein Nx6.25.	% Fiber.	% Nitrogen-free extractive matter	% Fat
LXXXVI..	Timothy* *Phleum pratense*. In early bloom.....	8.29	4.77	8.75	26.77	47.64	3.78	5.21	9.54	29.19	51.94	4.12
LXXXVII.	Timothy† " " 10 days past bloom.......	7.97	3.67	7.00	26.82	51.08	3.46	3.99	7.60	29.14	55.51	3.76
LXXXVIII	Wild Oat Grass, *Danthonia spicata*. In full bloom ...	8.29	4.23	8.75	27.80	47.66	3.27	4.61	9.54	30.23	52.07	3.55
LXXXIX..	Red Top, *Agrostis vulgaris*. In full bloom...........	8.11	4.10	8.50	26.60	49.09	3.60	4.46	9.25	28.94	53.43	3.92
XCVI......	Blue Joint, *Calamagrostis Canadensis*. In bloom.....	6.80	5.32	9.50	33.85	42.16	2.37	5.70	10.19	36.32	45.25	2.54
XCVII.	Witch Grass, *Triticum repens*. In full bloom	6.45	5.25	7 31	28.73	49 52	2.74	5.61	7.81	30.71	52.94	2.93
XC....	Alsike Clover, *Trifolium hybridum*. In full bloom....	8.45	6.54	12.50	28.00	40.63	3.88	7.14	13.65	30.58	44.39	4.24

* Yield per acre of dry hay, 3233 lbs.

† Yield per acre of dry hay.

The relative composition of the various hays can be more accurately shown by comparing the averages of the analyses for several years.

AVERAGE COMPOSITION OF HAYS FROM VARIOUS GRASSES CUT ON SAME FARM.

	In 100 parts water-free substance.				
	Ash.	Protein.	Fiber.	Nitrogen from extractive matter.	Fat.
Timothy Hay, '84, from general lot of hay*	4.49	7.86	34.36	50.65	2.64
Timothy Hay, " " " " " *	4.00	7.10	34.50	52.07	2.33
Timothy Hay, '85, in bloom*	6.47	7.67	38.50	43.70	3.66
Timothy Hay, '86, two weeks past bloom, average two analyses†	4.03	6.21	32.07	54.61	3.08
Timothy Hay, '87, in full bloom‡	4.58	8.18	32.66	50.98	3.60
Timothy Hay, '87, somewhat past bloom‡	5.17	7.84	32.10	51.30	3.59
Timothy Hay, '88, in early bloom	5.21	9.54	29.19	51.94	4.12
Timothy Hay, '88, ten days past bloom	3.99	7.60	29.14	55.51	3.76
Red Top Hay, '87, in full bloom§	5.06	9.69	30.98	50.64	3.63
Red Top Hay, '88, " "	4.46	9.25	28.94	53.43	3.92
Witch Grass Hay, '85, in bloom*	6.79	9.33	36.88	43.86	3.14
Witch Grass Hay, '87, " " ‡	5.41	9 53	38.07	43.21	3.78
Witch Grass Hay, '88, " "	5.61	7.81	30.71	52.94	2.93
Wild Oat Grass Hay, '87, in bloom‡	3.81	7.49	34.10	51.74	2.86
Wild Oat Grass Hay, '88, " "	4.61	9.54	30.23	52.07	3.55
Blue Joint Hay, '86, in bloom*	5.88	12.00	39.88	38.54	3.70
Blue Joint Hay, '87, " " ‡	5.97	10.06	36.22	44.66	3.09
Blue Joint Hay, '88, " "	5.70	10.19	36.32	45.25	2.54
Timothy Hay, average 3 years, in bloom	5.42	8.46	33.45	48.88	3.79
Red Top Hay, " 2 " " "	4.76	9.47	29.96	52.03	3.78
Witch Grass Hay, " 3 " " "	5.94	8.89	35.22	46.67	3.28
Wild Oat Grass Hay, average 2yrs. in "	4.21	8.51	32.16	51.91	3.21
Blue Joint Hay, average 3yrs. in bloom	5.85	10.75	37.47	42.82	3.11

* Report Maine Experiment Station, 1885-6, page 51.
† Ibid, 1886-7, page 68.
‡ Ibid, 1888, page 86.

A study of the above figures reveals the following facts:

(1.) The same species of grass may vary greatly in composition from year to year, even in the same locality, and at the same stage of growth as, for instance, in the case of the Timothy and Witch Grass.

(2.) The upland species of grass, so far examined at the same stage of growth do not differ in composition in a marked manner, except that Witch Grass appears to contain a rather large relative percentage of fiber. The Red Top compares very favorably with the other grasses. The texture, composition and digestibility (see later) of this grass commend it as one that should more frequently find a place in seed mixtures for permanent grass lands. Blue Joint, probably the most valuable of lowland grasses,

contains a comparatively larger average percentage of nitrogenous material, but is relatively woody. At the same time, if cut in bloom, or soon after, instead of being allowed to stand until so late, it makes a valuable fodder, and one that is superior to the poorer grades of hay from upland grasses.

DIGESTIBILITY OF HAYS FROM GRASSES AND OTHER FODDER PLANTS.

The hays cut in 1888 on the College Farm, the analyses of which are given on page 38, were submitted to digestion tests, that is, the actual amount of available nutritive material contained in them has been determined by experiments with animals.

The principles and methods involved in a digestion experiment are explained on pages 90-92 of the Station Report for 1888, and are briefly summarized below:

(1.) Only that portion of the food which is dissolved by the juices of the stomach and intestines and taken into the blood, is available for use in sustaining life or producing growth.

(2.) The solid excrement or dung is the undissolved or unused portion of the food, therefore:

(3.) The difference between what the animal takes in as food and excretes in the feces constitutes the dissolved, digested or useful portion.

A digestion experiment, then, consists simply in feeding an animal a known and uniform daily ration, determining at the same time the composition of the food and the weight and composition of the solid excrement. This has been done by the Station in 1888-9 with quite a number of cattle foods, sheep being used as the experimental animals. Repeated observations have shown that the various classes of ruminants are practically alike as to the manner and extent of their digestive processes, so that what is true for sheep would be true for cows and oxen. (For fuller details of methods used in the digestion experiments see Station Report for 1888, pp. 91-92.)

The data needed for the calculation of the coefficients or percentages of digestibility are the following:

(1.) Composition of food.

(2.) Composition of feces.

(3.) Weights of food eaten and feces excreted.

The composition of the foods is already given on page 38. The other data can be found in the two following tables.

COMPOSITION OF FECES.

FROM		Fresh feces.		In 100 parts water-free substance.				
Station Number.	FODDER.	Water.	Dry substance.	Ash.	Protein.	Fiber.	Nitrogen-free substance.	Fat.
		%	%	%	%	%	%	%
LXXXVI..	Timothy, Early Cut, Sheep 1.....	56.04	43.96	6.54	9.66	31.87	47.56	4.37
"	" " " " 2.....	61.46	38.54	7.10	10.16	30.47	47.67	4.60
LXXXVII.	Timothy, Late Cut, " 1.....	79.05	20.95	7.10	9.69	32.32	47.13	3.76
"	" " " " 2.....	64.77	35.23	5.78	8.63	32.93	48.90	3.76
LXXXVIII	Wild Oat Grass, " 3.....							
"	" " " " 4.....	61.10	38.90	6.95	9.64	28.06	51.19	4.16
LXXXIX..	Red Top, " 1. ...	47.60	52.40	7.59	8.97	29.31	49.56	4.57
"	" " " 2.....	60.00	40.00	7.89	9.33	29.25	49.25	4.28
XCVI......	Blue Joint, " 3.....	56.38	43.62	8.84	9.60	32.78	44.75	4.03
"	" " " 4.....	67.42	32.58	9.75	9.73	31.12	45.69	3.71
XCVII.....	Witch Grass, " 1.....	72.55	27.45	9.56	10.58	33.40	42.81	3.65
"	" " " 2.....	67.55	32.45	7.91	8.99	35.30	44.35	3.45
XC....	Alsike Clover, " 3.....	70.57	29.43	9.20	11.48	36.80	38.27	4.25
"	" " " 4.....	76.25	23.75	9.42	11.80	35.44	39.69	3.65

WEIGHTS OF FOOD EATEN AND FECES EXCRETED.

		Total food consumed in five days.		Total feces excreted in five days.	
		Air dry grams.	Water-free grams.	Fresh grams	Water-free grams.
LXXXVI..	Timothy, Early Cut, Sheep 1...	3500	3209.8	2933	1289.3
"	" " " 2...	3500	3209.8	3251	1252.9
LXXXVII..	Timothy, Late Cut, Sheep 1...	3500	3221.	5985	1253.9
"	" " " 2...	3500	3221.	4060	1430.7
LXXXVIII	Wild Oat Grass, Sheep 3...	3500	3209.8	3995	
"	" " " 4...	3500	3209.8	2615	1017.5
LXXXIX..	Red Top, Sheep 1...	3500	3216.	2377	1245.6
"	" " 2...	3500	3216.	3035	1213.8
XCVI......	Blue Joint, Sheep 3...	2100*	1957.2	1321*	576.3
"	" " 4...	2100*	1957.2	2000*	651.6
XCVII.	Witch Grass, Sheep 1...	2100*	1964.6	2667*	732.2
"	" " 2...	2100*	1964.6	2296*	745.2
XC.........	Alsike Clover, Sheep 3...	3500	3204.3	4233	1245.9
"	" " 4...	3500	3204.3	4813	1142.9

* For only three days.

The next table gives the coefficients or percentages of digestibility of the several hays. This table also shows somewhat in detail the figures and method involved in the calculation from the data of the two previous tables.

DIGESTIBILITY OF VARIOUS HAYS.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
LXXXVI, TIMOTHY HAY, early-cut.							
Sheep 1.							
Fed in five days	3209.8	3042.6	167.23	306.21	936.94	1667.17	132.25
Excreted in feces in five days	1289.3	1205.0	84.32	124.54	410.90	613.19	56.34
Digested	1920.5	1837 6	82.91	181.67	526.04	1053.98	75.90
Per cent. digested	59.83	60.37	49.57	59.33	56.14	63.23	57.39
Sheep 2.							
Fed in five days	3209.8	3042.6	167.23	306.21	936.94	1667.17	132.24
Excreted in feces in five days	1252.9	1163.9	88.96	127.30	381.78	597.30	57.64
Digested	1956.9	1878.7	78.27	178.91	555.16	1069.87	74.60
Per cent. digested	60.96	61.75	46.80	58.43	59.25	64.17	56.41
Avg. per cent. digested by 2 animals.	**60.40**	**61.06**	**48.18**	**58.88**	**57.69**	**63.70**	**56.90**
LXXXVII, TIMOTHY HAY, late cut.							
Sheep 1.							
Fed in five days	3221.	3092.5	128.52	244.80	938.60	1787.98	121.11
Excreted in feces in five days	1253.9	1164.9	89.02	121.50	405.20	590.92	47.14
Digested	1967.1	19 7.6	39.50	123.35	33.40	1197.06	73.97
Per cent. digested	61.07	62.33	30.73	50.36	56.83	66.95	61.07
Sheep 2.							
Fed in five days	3221.	3092.5	128.52	244.80	938.60	1787.98	121.11
Excreted in feces in five days	1430.7	1348.0	82.70	123.48	471.16	699.66	53.80
Digested	1790.3	1744.5	45.82	121.32	467 44	1088.32	67.30
Per cent. digested	55.58	56.41	35.66	49.56	49.80	60.87	55.57
Avg. per cent. digested by 2 animals.	**58.32**	**59.37**	**33.20**	**49.96**	**53.31**	**63.91**	**58.32**
LXXXVIII WILD OAT GRASS.							
Sheep 3.							
Fed in five days	3209.8	3061.8	147.97	306.21	970.32	1671.34	113.95
Excreted in feces in five days	1017.5	946.8	70.72	98.10	285.54	520.90	42.34
Digested	2192.3	2115.0	77.25	208.11	684.78	1150.44	71.61
Per cent. digested.	**68.30**	**69.07**	**52.20**	**67.96**	**70.57**	**68.84**	**62.84**
LXXXIX. RED TOP.							
Sheep 1.							
Fed in five days	3216.1	3072.7	143.44	297.49	930.74	1718.36	126.07
Excreted in feces in five days	1245.6	1151.1	94.54	111.72	365.08	617.4	56.92
Digested	1970.5	1921.6	48.90	185.77	565.66	1100.96	69.15
Per cent. digested	61.27	62.31	34.09	62.44	60.77	64.07	54.85
Sheep 2.							
Fed in five days	3216.1	3072.7	143.44	297.49	930.74	1718.36	126.07
Excreted in feces in five days	1213.8	1118.	95.76	113.24	355.04	597.80	51.96
Digested	2002.3	1954.7	47.68	184.25	575.70	1120.56	74.11
Per cent. digested	62.26	63.61	33.24	61.93	61.85	65.21	58.78
Avg. per cent. digested by 2 animals.	**61 76**	**62.96**	**33 66**	**62.18**	**61.31**	**64.64**	**56.81**

DIGESTIBILITY OF VARIOUS HAYS—(Continued).

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
XCVI Blue Joint.							
Sheep 3.							
Fed in three days	1957.2	1845.6	111.56	199.44	710.86	885.63	49.71
Excreted in feces in three days	576.3	525.4	50.94	55.32	188.91	257.89	23.22
Digested	1380.9	1320.2	60.62	144.12	521.95	627.74	26.49
Per cent. digested	70.55	71.53	54.34	72.26	73.43	70.88	53.29
Sheep 4.							
Fed in three days	1957.2	1845.6	111.56	199.44	710.86	885.63	49.71
Excreted in feces in three days	651.6	588.1	63.53	63.40	202.78	297.72	24.17
Digested	1305.6	1257.5	48.03	136.04	508.08	587.91	25.54
Per cent. digested	66.70	68.13	43.05	68.21	71.47	66.38	51.38
Avg. per cent. digested by 2 animals	**68.6**	**69.8**	**48.70**	**70.23**	**72.45**	**68.63**	**52.33**
XCVII Witch Grass.							
Sheep 1.							
Fed in three days	1964.6	1854.4	110.2	153.44	603.33	1040.06	57.56
Excreted in feces in three days	732.2	662.2	70.	77.47	244.55	313.45	26.72
Digested	1232.4	1192.2	40.2	75.97	358.78	726.61	30.84
Per cent. digested	62.73	64.29	36.47	49.51	59.46	69.86	53.58
Sheep 2.							
Fed in three days	1964.6	1854.4	110.20	153.44	603.33	1040.06	57.56
Excreted in feces in three days	745.2	686.1	58.94	66.99	263.06	330.50	25.71
Digested	1219.4	1168.3	51.26	86 45	340.27	709.56	31.85
Per cent. digested	62.07	63.00	46.51	56.34	56.39	68.22	55.33
Avg. per cent. digested by 2 animals	**62.40**	**63.64**	**41.49**	**52.92**	**57.92**	**69 04**	**54.45**
XC Alsike Clover.							
Sheep 3.							
Fed in five days	3204.3	2975.5	228.79	437.39	979.87	1422.39	135.86
Excreted in feces in five days	1245.9	1131.3	114.62	143.02	458.46	476.76	52.94
Digested	1958.4	1844.2	114.17	294.37	521.41	945.63	82.92
Per cent. digested	61.12	61.98	49.90	67.30	53.21	66.48	61.03
Sheep 4.							
Fed in five days	3204.3	2975.5	228.79	437.39	979.87	1422.39	135.86
Excreted in feces in five days	1142.9	1035.2	107.66	134.86	405.	453.58	41.72
Digested	2061.4	1940.3	121.13	302.53	574.87	968.81	94.14
Per cent. digested	64.33	65.20	52.94	69.16	58.67	68.11	69.29
Avg. per cent. digested by 2 animals	**62.72**	**63.59**	**51.42**	**68.23**	**55.94**	**67.29**	**65.16**

In order to facilitate a comparison of these coefficients of digestibility they are summarized below.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
Timothy Hay, early cut	60.40	61.06	48.18	58.88	57.69	63.70	56.90
" " late cut	58.32	59.37	33.20	49.96	53.31	63.91	58.32
Wild Oat Grass	68.30	69.07	52.20	67.96	70.57	68.84	62.84
Red Top	61.76	62.96	33.66	62.18	61.31	64.64	56.81
Blue Joint	68.60	69.80	48.70	70.23	72.45	68.63	52.33
Witch Grass	62.40	63.64	41.49	52.92	57.92	69.04	54.45
Alsike Clover	62.72	63.59	51.42	68.23	55.94	67.29	61.16

It is but fair to remark that the collection of the feces from the Blue Joint and Witch Grass for so short a time as three days, renders the coefficients for those days less reliable than in the other cases.

COMPOSITION, DIGESTIBILITY AND YIELD OF EARLY-CUT AND LATE-CUT TIMOTHY.

In the summer of 1888, a very uniform field of Timothy grass was divided into six plots, each plot being 236 feet long and 47 feet wide. Plots 1, 3, and 5 were cut July 9th while the Timothy was in early bloom, and plots 2, 3 and 6 were cut July 24th, fifteen days later. In both cases the grass was carefully cured, and the two cuttings were stored separately so that the hay could be re-weighed, which was done on November 28th. About a hundred pounds of each lot of hay was finely chopped for use in the determination of their composition and digestibility.

The composition of these two hays has already been given, but is re-stated below for the purpose of comparison.

	% Ash.	% Protein.	% Fiber.	% Nitrogen-free extractive matter.	% Fat.
Timothy, cut July 9th	5.21	9.54	29.19	51.94	4.12
Timothy, cut July 24th	3.99	7.60	29.14	55.51	3.76
Difference	1.22	1.94	.05	-3.57	.36

The digestibility of the hays is also compared in the next table, the figures given being the percentages of digestibility.

	Dry substance.	Organic matter.	Ash.	% Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
Timothy, cut July 9th...........	60.40	61.06	48.18	58.88	58.69	63.70	56.90
" cut July 24th..........	58.32	59.37	32.20	49.96	53.31	63.91	58.32

The following figures show the weights of hay from the two cuttings.

	Lot cut July 9th.	Lot cut July 24th.
Weight when put in barn.........	2815 lbs.	2790 lbs.
" on Nov. 28th......	2470 "	2420 "
Loss by drying in barn...........	345 lbs.	370 lbs.
Per cent. loss in barn.............	12.2%	13.3%
Yield dry hay per acre...........	3233 lbs.	3168 lbs.

The especial uniformity of the grass on this experimental field warrants the belief that the above figures represent very fairly the relative yield of hay from early-cut and late-cut grass under the existing conditions. The grass as this field had been attacked for several years by an insect, the larva of which feeds on the inner portion of the culm (stalk) and causes the death of the upper portion of the plant.

Probably one-fifth of the grass plants on this field was thus affected in 1888, and the above results indicate that longer standing gave a decreased rather than the usual increased yield. On the other hand, the season was such as to promote an undergrowth of short grass, so that the hay harvested late in July does not seem to differ much in composition, digestibility or yield from the former cutting, although in all respects there is a small balance in favor of the early cut hay.

THE COMPOSITION AND YIELD OF FODDER FROM THREE VARIETIES OF CORN, AND THE DIGESTIBILITY OF THE SAME BOTH AS DRIED FODDER AND AS ENSILAGE.

The corn plant is an important source of cattle food. This is especially true now that this crop is so largely grown to be converted into ensilage, and now that we have come to more fully appreciate and more economically use, by means of the silo, what is left after removing the ears either for the sweet corn factory or for the ripe grain.

The matter of the relative yield of food from several varieties of corn when grown to be packed in the silo, is often discussed, as for instance, southern ensilage corn, common field corn, or sweet corn. How does the actual amount of nutritive material produced by these varieties under like conditions, compare?

With a view to obtaining an answer to this question, an experiment was undertaken in the summer of 1888, after the following plan:

Two acres of land, a fine loam, which had been in grass for several years was manured with 600 pounds of superphosphate per acre, drilled in with the seed. This, with the decaying sod, furnished the crop a fair amount of food.

This area was divided into twelve plots of equal size. On plots 1, 4, 7 and 10 was planted Southern Ensilage Corn; on plots 2, 5, 8 and 11 Common Field Corn, and on plots 3, 6, 9 and 12, Sweet Corn. The corn was planted in drills by the use of the Eclipse Corn Planter. The least quantity of seed that it was found possible to drill in with this machine, and at the same time secure uniformity, was more than desired, and the plots were somewhat too heavily seeded, though not greatly so.

The corn was planted on May 30th and 31st, and the fodder was cut Sept. 8th to 12th. The crop was well cultivated by both machine and hand work.

Three reasons exist why the results obtained in this experiment are less satisfactory than they otherwise would have been, viz:

The season of 1888 was unfavorable to the early maturity of the corn plant, being exceptionally wet, and although one hundred days elapsed between the planting and the harvesting, the crop was less mature than was necessary for the largest production. In the case of the field corn, a good many ears were fully devel-

oped, in sweet corn a few, and in the southern corn the formation of ears had not begun.

Again the field corn and sweet corn were attacked when a few inches high, and somewhat thinned by a cut worm. It is a question whether this thinning actually diminished the yield of fodder, but it disturbed to some extent the uniformity of conditions under which the three varieties grew. It is worthy of note that the cut worm entirely avoided the southern corn, but was found on every plot of the other two varieties.

To complete the list of calamities, the corn was frost bitten a few nights before it was harvested, though not severely. This latter misfortune could in no way materially affect the accuracy of the data as to the yield and composition of dry matter, but may be supposed to have had an influence on the palatableness of the fodder, and thus interfere with the success of an experiment involving digestion and feeding experiments. But notwithstanding these unfavorable conditions, it was decided to continue the experiment as planned, because a study of unsatisfactory results is often instructive, and in the case under consideration it is certainly worth while to know just how far short of success this crop of somewhat immature frost bitten fodder came. It is sometimes asserted that failures teach more than successes. Besides the original inquiries involved in the experiment, the adverse conditions mentioned above raise the additional inquiry as to the real quality for ensilage and feeding possessed by such material as the experiment furnished. A study was made of the following points:

(1) Yield of green fodder and dry matter.
(2) Composition of the fodder.
(3) Digestibility of the fodder.
(4) Actual effect of the fodder when fed as ensilage.

Yield of fodder. The fodder was hauled to the barn directly after cutting and was weighed before being chopped to pack in the silo. The yields of green fodder and dry substance are given in the table below, as also are the total yield, and calculated rate of yield per acre. The yields of dry matter are calculated by means of analytical data to be found later.

YIELD OF FODDER CORN.

	Southern Corn.			Field Corn.			Sweet Corn.		
	Plot.	Weight green.	Weight water-free substance.	Plot.	Weight green.	Weight water-free substance.	Plot.	Weight green.	Weight water-free substance.
		lbs.	lbs.		lbs.	lbs.		lbs.	lbs.
	1	4450	547.3	2	2325	404.5	3	1995	269.3
	4	4565	561.5	5	2495	434.1	6	2495	336.8
	7	3925	482.8	8	2140	362.4	9	2160	291.6
	10	4590	564.6	11	2515	437.6	12	2820	380.7
Total		17530	2156.2		9475	1638.6		9470	1278.4
Rate of yield per acre		**26295**	**3234.3**		**14212**	**2457.9**		**14205**	**1917.6**

No one of the varieties of corn yielded largely. and under the existing conditions this was not to be expected. In fact the experiment was planned with reference to a comparison of yield and not to secure a maximum crop.

The growth of dry matter, as well as of green fodder seems to have been much larger with the southern ensilage corn. Would this have been true under more favorable conditions? A future experiment must more definitely answer this question.

One fact is plainly seen, however, which is, that 36,475 pounds of green fodder contained only 5,073 pounds of dry matter, and 31,402 pounds of water, or in other words, over eighteen tons of green material grown on two acres, furnished only two and one-half tons of dry substance. This is less dry matter per acre than is furnished by the average grass crop on very many of our well tilled Maine hay farms, and in the case of the hay fifteen tons of water are not present to be lifted several times. There would be no reason for mentioning the poor economy of this crop were it not for the fact that many such crops of corn fodder have been grown and may still be grown in Maine on land of moderate fertility, and from late planted seed. More liberal manuring and greater maturity are essential conditions of success in the growth of the corn plant for the silo.

But the *amount* of dry matter is not the only factor involved in the consideration of nutritive value. The southern corn was harvested, as must always be the case in Maine, in a much more immature condition than the other two varieties. This fact must

effect the composition of the fodder, and the question arises: May not the smaller amount of dry matter in the more mature field corn have as great or greater value than the larger amount in the southern corn? Again, what is the quality of the dry matter in fodder corn of this sort? An answer to these questions must come from a knowledge of the composition and digestibility of the different varieties.

Composition of the fodder corn. When the plots of corn were cut samples were selected from quite a number of places in each plot and a few hundred pounds of each variety of fodder was weighed, and then stored in a place and manner favorable to drying. Late in November the three lots of partially dried fodder were finely chopped in a hay cutter, and were then spread out for additional drying. On December 6th, the chopped fodder was weighed, samples weighed out for analysis, and that used in the digestion experiments, which were then begun, was weighed into paper bags, The samples for analysis were dried still more until in a condition for grinding, and then re-weighed. The several weighings are recorded below:

	First drying.		Second drying.	
	Green corn stored.	Partially dried fodder obtained.	Partially dried fodder taken.	Air-dry fodder obtained.
	lbs.	lbs.	grams.	grams.
Southern Corn	450	94.5	800.	513
Field Corn	400	129.	800.	478
Sweet Corn	400	110.	800.	435

The air dry fodder as analyzed, contained moisture as follows: Southern Corn, 8.91 per cent., Field Corn, 9.75 per cent., Sweet Corn, 9.64 per cent.

From the data now given, it is possible to calculate the composition of the green fodder, and also of the water-free substance.

COMPOSITION OF FODDER CORN.

Station number.		In 100 parts green fodder. Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.	In 100 parts water-free substance. Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
		%	%	%	%	%	%	%	%	%	%	%	%
LXXXIII..	Southern Corn....	87.70	12.3	.87	1.49	3.95	5.67	.32	7.11	12.14	32.09	46.09	2.57
LXXXIV ..	Field Corn........	82.60	17.4	1.35	2.30	5.04	8.32	.39	7.79	13.22	8.95	47.80	2.24
LXXXV. ..	Sweet Corn.	86.40	13.5	.73	1.72	4.10	6.58	.37	5.45	12.73	30.35	48.74	2.73

The figures show that the southern corn fodder contained the most water, and the field corn the least. The composition of the dry matter seems not to differ in a marked manner, in the three cases, the proportion of protein to carbohydrate material being nearly the same, though the smaller varieties contained a somewhat larger proportion of protein, the field corn leading in this respect as in the amount of dry matter.

It is interesting to note how the composition of these fodders compares with the composition of the seventy-five samples of green corn fodder that had been analyzed in this country up to 1888. This average is:

Water.	Dry substance.	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.	
78.74	21.26	1.08	1.80	4.99	12.94	.45	....................Average
92.90	7.10		.70	1.90	3.20	.10	....................Minimum
51.50	48.50		3.00	11.4	22.10	1.80	....................Maximum

While these fodders did not prove to be quite up to the average quality, they are much better than the poorest that have been analyzed.

The composition of the partially dried fodder when chopped late in November, can also be determined from the analyses and weighings.

This fodder had been stored for nearly two months, spread out in a thin layer in a dry place, and the fact that it still retained from 40 to 50 per cent. of water shows how slowly such material dries, and how large is the proportion of water that we may expect to find in any corn fodder or stover consisting of the uncut stalks.

COMPOSITION OF PARTIALLY DRIED CORN FODDER.

	Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
Southern Corn Fodder..................	41.5	58.5	4.16	7.10	18.77	26.97	1.50
Field Corn Fodder........................	46.	54.0	4.20	7.14	15.63	25.82	1.21
Sweet Corn Fodder................	50.9	49.1	2.67	6.25	14.90	23.93	1.34

Digestibility of the fodder corn. The digestibility of these three varieties of fodder corn was determined by experiments with sheep, the plan followed being the same as that described in connection with former experiments. The usual data are given below:

COMPOSITION OF FECES.

FROM	Fresh feces.		In 100 parts water-free feces.				
	Water.	Water-free substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
	%	%	%	%	%	%	%
LXXXIII, Southern Corn Fodder, Sheep 1....	73.16	26.84	14 38	15.49	21.48	46.21	2.44
" " " " " 2....	64.47	35.53	12.14	13.66	24.95	47.10	2.15
LXXXIV, Field Corn Fodder, " 3....	61.58	38.42	14.67	16.01	19.12	47.90	2.30
" " " " " 4....	71.04	28.96	14.49	16.30	20.67	47.18	1.96
LXXXV, Sweet Corn Fodder, " 3....	58.06	41.94	10.49	15.08	23.04	49.03	2.36
" " " " " 4....	55.75	44.25	0.86	11.71	23.18	52.06	2.19

Weights of Food Eaten and Feces Excreted.

		Total food eaten in five days.		Total feces excreted in five days.	
		Partially air-dry.	Water-free.	Fresh.	Water-free.
		grams.	grams.	grams.	grams.
LXXXIII	Southern Corn Fodder, Sheep 1	4000	2336.4	2925.	784.9
"	" " " " 2	4000	2336.4	2395.	851.
LXXXIV	Field Corn Fodder, " 3	4000	2156.9	1735.	666.6
"	" " " " 4	4000	2156.9	2140.	619.8
LXXXV.	Sweet Corn Fodder, " 3	4000	1965.3	1794.	752.5
"	" " " " 4	4000	1965.3	1771.	783.6

Digestibility of Corn Fodder.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
LXXXIII Southern Corn Fodder.							
Sheep 1.							
Fed in five days	2336.4	2170.3	166.12	283.94	749.75	1076.85	60.05
Excreted in feces in five days	784.9	672.0	112.86	121.56	168.58	362.16	19.14
Digested	1541.5	1498.3	53.26	162.38	581.17	714.19	40.91
Per cent. digested	65.98	69.04	32.06	57.18	77.51	66.32	68.12
Sheep 2.							
Fed in five days	2336.4	2170.3	166.12	283.94	749.75	1076.85	60.05
Excreted in feces in five days	851.	753.7	103.32	116.24	212.32	400.82	18.30
Digested	1485.4	1416.6	62.80	167.70	537.43	676.03	41.75
Per cent. digested	63.57	65.27	37.80	59.06	71.68	62.77	69.52
Avg. per cent. digested by 2 animals	**64.77**	**67.15**	**34.93**	**58.12**	**74.59**	**64.54**	**68.82**
LXXXIV Field Corn Fodder.							
Sheep 3.							
Fed in five days	2156.9	1988.9	168.02	285.14	624.42	1030.99	48.31
Excreted in feces in five days	666.6	568.8	97.80	106.72	127.46	319.30	15.34
Digested	1490.3	1420.1	70.22	178.42	496.96	711.69	32.97
Per cent. digested	69.09	71.40	41.79	62.57	79.58	69.02	68.25
Sheep 4.							
Fed in five days	2156.9	1988.9	168.02	285.14	624.42	1030.99	48.31
Excreted in feces in five days	619.8	530.8	89.80	101.02	124.40	292.42	12.14
Digested	1537.1	1458.1	78.22	184.12	500.02	738.57	36.17
Per cent. digested	71.26	73.31	46.55	64.57	80.07	71.63	74.87
Avg. per cent. digested by 2 animals	**70.17**	**72.35**	**44.17**	**63.57**	**79.82**	**70.32**	**71.56**
LXXXV Sweet Corn Fodder.							
Sheep 3.							
Fed in five days	1965.3	1858.2	107.11	250.18	596.47	957.89	53.65
Excreted in feces in five days	752.5	673.6	78.92	113.46	173.36	368.90	17.76
Digested	1212.8	1184.6	28.19	136.72	423.11	588.99	35.89
Per cent. digested	61.71	63.75	26.32	54.65	70.93	61.48	66.89
Sheep 4.							
Fed in five days	1965.3	1858.2	107.11	250.18	596.47	957.89	53.65
Excreted in feces in five days	783.6	698.5	85.10	91.76	181.64	407.94	17.16
Digested	1181.7	1159.7	22.01	158.42	414.83	549.95	36.49
Per cent. digested	60.12	62.40	20.54	63.32	69.54	57.41	68.01
Avg. per cent. digested by 2 animals	**60.91**	**63.07**	**23.43**	**58.98**	**70.23**	**59.44**	**67.45**

Composition and digestibility of the ensilage from the three varieties of corn. Each variety of fodder corn used in this experiment was cut and packed in the silo separately. The green fodder was hauled to the barn as soon as cut and immediately chopped and packed. The fodder cutter used was the Lion Fodder Cutter, No. 2, manufactured by Hank & Comstock, Mechanicsburg, Pa., which not only cuts the fodder to any desired length, but also crushes the coarse pieces of stalk.

The silo was not opened until late in February, and the contents were found to be in good condition, save the usual layer of poor material at the surface. The ensilage was of fair quality, and was certainly greedily eaten, especially by the cows.

While each kind of ensilage was being eaten, samples were selected daily during two weeks for use in digestion experiments with sheep, as well as for analysis. It is not claimed that the analyses fairly represent the entire contents of the silo, but only that part used in the digestion experiments, which, however, could not be greatly different from the whole mass of material. The analyses of the ensilage follow:

COMPOSITION OF ENSILAGE.

Station Number.		In 100 parts fresh ensilage.							In 100 parts water-free substance.				
		Water.	Dry substance.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
XCIX	Southern corn ensilage	82.22	17.78	1.05	1.82	5.70	8.70	0.51	5.94	10.22	32.05	48.93	2.86
XCIV	Field corn ensilage....	83.08	16.92	0.86	2.00	4.34	8.75	0.99	5.08	11.81	25.65	51.63	5.83
XCV.	Sweet corn ensilage...	83.49	16.51	0.87	1.97	4.07	8.60	1.00	5.26	11.94	24.63	52.10	6.07

The further data necessary to the calculation of the digestibility are given below. The experiments furnishing this data were continued for twelve days, the feces being collected during the last five:

Composition of Feces.

FROM	Water.	Dry substance.	In 100 parts water-free substance. Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
XCIX, Southern Corn Ensilage, Sheep 3...	66.16	33.84	14.10	14.60	22.31	46.00	2.99
" " " " " 4....	68.32	31.68	13.44	15.05	23.24	45.61	2.66
XCIV, Field Corn Ensilage, " 3....	78.81	21.19	14.35	20.20	20.58	41.57	3.30
" " " " " 4....	62.84	37.16	14.26	15.65	20.30	46.58	3.21
XCV, Sweet Corn Ensilage, " 1....	59.83	40.17	10.85	16.92	23.25	45.77	3.21
" " " " " 2....	74.28	25.72	11.63	17.62	21.28	46.40	3.07

Weights of Food Eaten and Feces Excreted.

		Food eaten in five days. Fresh.	Water-free.	Feces excreted in five days. Fresh.	Water-free.
		grams.	grams.	grams.	grams.
XCIX ..	Southern Corn Ensilage, Sheep 3	7500	1333.5	1345	455.1
"	" " " " 4	7500	1333.5	1658	525.4
XCIV...	Field Corn " " 3	7500	1279.	1817	385.1
"	" " " " 4	7500	1279.	1092	405.8
XCV....	Sweet Corn " " 1	7500	1238.2	1030	413.8
"	" " " " 2	7500	1238.2	1462	376

DIGESTIBILITY OF ENSILAGE.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
XCIX, SOUTHERN CORN ENSILAGE.							
Sheep 3.							
Fed in five days	1333.5	1254.3	79.23	136.32	427.51	652.68	38.15
Excreted in feces in five days	455.1	390.9	64.16	66.44	101.52	209.30	13.60
Digested	878.4	863 4	15.07	69.88	325.99	443.38	24.55
Per cent. digested	65.87	68.75	19.02	51.26	76.25	67.93	64.35
Sheep 4.							
Fed in five days	1333.5	1254.3	79.23	136.32	427.51	652.68	38.15
Excreted in feces in five days	525.4	454.4	70.62	79.08	122.10	239.64	12.88
Digested	808.1	799.9	8.61	57.24	305.40	413.04	25.27
Per cent. digested	60.59	63.77	10.87	41.98	71.45	63.29	66.24
Avg. per cent. digested by 2 animals.	**63.23**	**66.26**	**14.94**	**46.62**	**73.85**	**65.61**	**65.30**
XCIV, FIELD CORN ENSILAGE.							
Sheep 3.							
Fed in five days	1279.	1214.5	64.46	149.86	325.47	655.13	73.98
Excreted in feces in five days	385.1	329.8	55.26	77.79	79.25	160.09	12.71
Digested	893.9	884.7	9.20	72.07	246.22	495.04	61.27
Per cent. digested	69.89	72.84	14.27	48.09	75.65	75.56	82.82
Sheep 4.							
Fed in five days	1279.	1214.5	64.46	149.86	325.47	655.13	73.98
Excreted in feces in five days	405.8	347.9	57.86	63.50	82.38	189.02	13.02
Digested	873.2	866.6	6.60	86.36	243 09	466.11	60.96
Per cent. digested	68.27	71.35	10.24	57.62	74.68	71.15	82.40
Avg. per cent. digested by 2 animals	**69.08**	**72.09**	**12.25**	**52.85**	**75.16**	**73.35**	**82.61**
XCV, SWEET CORN ENSILAGE.							
Sheep 1.							
Fed in five days	1238.2	1173.1	65.12	147.82	304.92	645.98	75.15
Excreted in feces in five days	413.8	368.9	44.90	69.96	96.20	189.40	13.28
Digested	824.4	804.2	20.22	77.86	208.72	456.58	61.87
Per cent. digested	66.58	68.55	31.05	52.67	68.44	70.68	82.33
Sheep 2.							
Fed in five days	1238.2	1173.1	65.12	147.82	304.92	645.98	75.15
Excreted in feces in five days	376.	332.3	43.72	66.26	80.00	174.46	11.54
Digested	862.2	840.8	21.40	81.56	224.92	471.52	63.61
Per cent. digested	69.63	71.67	32.86	55.17	73.76	72.99	84.64
Avg. per cent. digested by 2 animals	**68.10**	**70.11**	**31.95**	**54.01**	**71.10**	**71.83**	**83.48**

The digestibility of these varieties of corn having been determined both as fodder and as ensilage, it is now possible to compare the figures obtained. It is interesting to note whether ensilage is greatly more or less digestible than the original material converted into dried fodder:

COMPARISON OF DIGESTIBILITY OF CORN FODDER AND ENSILAGE.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
SOUTHERN CORN.							
As fodder	64.77	67.15	34.93	58.12	74.59	64.54	68.82
As ensilage	63.23	66.26	14.94	46.62	73.85	65.61	65.30
Difference	+1.54	+.89	+19.99	+11.50	+.74	-1.07	+3.52
FIELD CORN.							
As fodder	70.17	72.35	44.17	63.57	79.82	70.32	71.56
As ensilage	69.08	72.09	12.25	52.85	75.16	73.35	82.61
Difference	+1.09	+.26	+31.92	+10.72	+4.66	-3.03	-11.05
SWEET CORN.							
As fodder	60.91	63.07	23.43	58.98	70.23	59.44	67.45
As ensilage	68.10	70.11	31.95	54.01	71.10	71.83	83.48
Difference	-7.19	-7.04	-8.52	+4.97	-.87	-12.39	-16.03

These figures from actual trials furnish no evidence that the fermentation which a fodder undergoes in the silo greatly affects its digestibility, and they accord with the results of previous tests.

In view of the unanimity of testimony in this point, there seems to be no reason for perpetuating the statement through our agricultural papers, that ensilage is more digestible than the original material when dried. In fact, there is good reason for believing that if a fodder can be so quickly and perfectly dried that it suffers no change in composition, its percentage of digestibility will be greater than that of the ensilage made from it, because the fermentation in the silo destroys some of the soluble and perfectly digestible compounds in the fodder.

In practice, however, fodder is not generally dried without loss similar to that which takes place in the silo, and so in discussing the advantages of the silo, the matter of a greater or less

digestibility does not seem likely to furnish an argument either pro or con.

Summary. The previously described results of a somewhat careful study of the composition and digestibility of immature fodder corn, harvested under unfavorable conditions, make a very good showing for the nutritive value of whatever of dry substance the fodder contained. It can by no means be said that such material is worthless, but it is fairer to claim that its dry matter has a greater feeding value, pound for pound, than that of much hay that is fed. Immaturity implies a low nutritive value, only so far as it is an indication of the presence of a very large percentage of water. June pasture grass is made up of immature plants, but who does not know that its dry substance is very nutritious?

The indictment against the crops of fodder corn obtained in this experiment is the small amount of dry matter harvested. The appearance of the plots of Southern corn, especially, indicated a crop by no means small, and the scales made a showing of over thirteen tons of green material per acre, but the close inspection of the laboratory shows that this large bulk of fodder yielded less than one and two-thirds tons of actual food substance.

Any crop, so bulky and so largely water, such as roots and fodder corn, is likely to be deceptive as to its real food value.

(1.) The dry substance in 100 lbs. of the somewhat immature green fodder from three varieties of corn varied from 12.3 lbs. to 17.4 lbs.

(2.) The dry substance in 37,475 lbs. of green fodder was 5,073 lbs. Of the Southern Corn 26,295 lbs. contained only 3,234 lbs. of dry matter.

(3.) The dry substance of these fodders was found to have a composition and high relative rate of digestibility that indicate good nutritive quality.

(4.) The digestion experiments do not show a superior digestibility for the ensilage over the dried fodder.

Composition and Value of Various Commercial Feeding Stuffs.

J. M. Bartlett.

The idea of collecting and analyzing a few samples of the feeding stuffs offered for sale in our markets was suggested to the writer by frequent inquiries from the farmers as to the relative value of the various milling products and other concentrated cattle foods now sold by dealers.

Three samples of nearly every food were taken in as many different towns, in order to obtain some idea of the amount of variation in the composition of the same brands. The detailed analyses showing the composition of the samples collected are given in tabular form on page 59. Furtheron is shown the amounts of digestible nutrients calculated from the average of the analyses of each food, and these figures possibly may be of some service to the intelligent farmer in buying and feeding economically. In the report of this Station for 1888, page 108, can be found the method for calculating rations, and on the following pages, feeding standards, composition of American fodders, their digestibility, etc., that farmers can make use of in making up rations.

It is undoubtedly true that the intelligent buyer can materially lessen the cost of feeding his animals by studying the composition of the foods offered for sale, and buying those which will furnish the nutrients he especially needs, at the lowest price. For instance it will be seen below that a little more digestible protein, fat and carbohydrates can be obtained from fifty pounds of wheat bran and fifty pounds middlings than from one hundred pounds of oats. The bran and middlings at present prices, would cost about $1.00, while the oats would cost about $1.25. Again if one has a fodder rich in carbohydrates and wishes to buy protein to make a proper ration, it could be much more cheaply obtained in cottonseed or gluten meal, or any food rich in protein, than in corn meal which is poor in protein, providing the large amount of carbohydrates the corn contains is not needed.

The reverse would also be true if one wished to buy carbohydrates, they could be more cheaply purchased in corn meal than in cottonseed meal or gluten meal. It is not possible for us to say which foods are always most economical, because prices fluctuate so that what would be true to-day might not be true three months hence, but the buyer must ascertain his needs, study the composition of the foods in the market, and their prices, and use his own ju lgment in purchasing.

Composition of Commercial Feeding Stuffs.

Laboratory Number.		Water.	Dry substance.	Ash.	Protein Nx6 25.	Fiber.	Nitrogen-free extractive matter.	Fat.	Per cent. protein digestible in pepsin solution.
		%	%	%	%	%	%	%	
LVI	White Wheat Bran	12.07	87.93	6.27	16.56	8.53	52.35	4.22	86.03
LVII	" " "	11.50	88.50	6.27	16.81	7.55	53.30	4.57	86.25
LVIII	" " "	10.80	89.20	6.22	17.69	7.48	53.96	3.85	81.98
	Average	**11.46**	**88.54**	**6.25**	**17.02**	**7.85**	**53.20**	**4.22**	**84.75**
LIX	Red Wheat Bran	12.50	87.50	6.40	16.94	6.35	53.56	4.25	81.55
LX	" " "	11.05	88.95	6.55	16.81	7.50	53.11	4.98	82.16
LXI	" " "	11.05	88.95	6.25	16.38	10.15	50.54	5.63	84.74
	Average	**11.54**	**88.46**	**6.40**	**16.71**	**8.00**	**52 40**	**4.95**	**82.81**
LXII	Wheat Middlings	12.15	87.85	3.58	19.13	4.00	55.49	5.65	90.52
LXIII	" "	11.60	88.40	3.10	16.81	4 15	60.54	3.50	90.34
LXIV	" "	11.00	89.00	3.42	18.93	3.20	58.59	4.86	91.75
LXV	" "	11.87	88.13	5.10	18.31	6.36	53.19	5.17	87.03
	Average	**11.66**	**88 34**	**3.80**	**18.29**	**5 50**	**56.95**	**4.79**	**89.91**
LXVI	Wheat Middlings (fancy)	11.00	89.00	1.45	17.75	2.90	63.12	3.78	91.20
LXVII	" " "	10.45	89.55	1.62	14.19	4.51	65.86	3.37	89.43
LXVIII	" " "	10.65	89.35	2 80	13.75	3.72	64.91	4.17	90.67
	Average	**10.70**	**89.30**	**1.95**	**15.23**	**3.71**	**64.65**	**3.77**	**90.43**
LXIX	Feed Flour	9.90	90.10	2.75	20.87	3.66	57.98	4.80	95.01
LXX	" "	11.30	88.70	.95	20.	1.64	61.66	4.72	94.56
	Average	**10.90**	**89.40**	**1.85**	**20.43**	**2,65**	**59.82**	**4.75**	**94.78**
LXXI	Corn Meal	12.27	87.73	1:26	10.00	2.72	69.74	3.81	82.50
LXXII	" "	11.69	88.31	1.02	9 94	2.42	71.06	3.87	83.02
LXXX	" "	12.50	87.50	1.14	10 00	1.80	70.29	4.27	83.13
	Average	**12.16**	**87.84**	**1.14**	**9.98**	**3.98**	**70.36**	**2.31**	**82.88**
LXXIII	Ground Oats	11.48	88.52	2.87	12.52	9.23	60.36	4.00	87.05
LXXXI	" "	11.14	88.86	3.21	13.56	8.57	58.38	5.14	91.24
	Average	**11.31**	**88.69**	**3.04**	**13.64**	**8.90**	**59.37**	**4 57**	**89 14**
LXXIV	Cotton Seed Meal	7.11	92.89	6.89	44.38	6.40	21.53	13.69	87.89
LXXVII	" " "	7.94	92.06	6.23	44.75	3.44	18.74	18.90	91.34
LXXVIII	" " "	7.52	92.48	5.38	49.18	5.75	21.52	10.65	89.33
	Average	**7.53**	**92.47**	**6 16**	**46.10**	**5.20**	**20.59**	**14.41**	**89.52**
LXXV	Linseed Meal	8.58	9[illegible].42	5.26	38.12	8.28	32.27	7.49	92.13
LXXVI	" "	8.91	91.09	4.72	37.88	7.39	22.15	18.95	98.58
	Average	**8.75**	**91.25**	**4.99**	**38.00**	**7.83**	**27.21**	**13.22**	**95.35**

DIGESTIBLE NUTRIENTS IN ONE HUNDRED POUNDS.

Red Wheat Bran.

Protein	12.37	pounds.
Fat	4.11	"
Carbohydrates	35.11	"

White Wheat Bran.

Protein	12.59	pounds.
Fat	3.49	"
Carbohydrates	35.64	"

Red Wheat Middlings.

Protein	14.84	pounds.
Fat	4.45	"
Carbohydrates	46.28	"

Fancy Middlings.

Protein	12.03	pounds.
Fat	3.20	"
Carbohydrates	53.64	"

The coefficients used in calculating the digestible nutrients in the bran and middlings were obtained by experiments with animals, recently made at this Station. They are for

	Protein %	Carbohydrates %	Fat %
Bran	74	67	83
Middlings	79	83	85

Feed Flour.

Protein	16.15	pounds.
Fat	4.07	"
Carbohydrates	49.65	"

We were somewhat surprised to find the feed flour so rich in protein, which seems to indicate that gluten meal or some other highly nitrogenous material was mixed with it. The coefficients for middlings were used in calculating the digestible matter.

Corn Meal.

Protein	8.48	pounds.
Fat	3.02	"
Carbohydrates	66.14	"

Ground Oats.

Protein	10.04	pounds.
Fat	3.75	"
Carbohydrates	43.93	"

Cottonseed Meal.

Protein	40.57	pounds.
Fat	12.25	"
Carbohydrates	19.56	"

Linseed Meal.

Protein	32.68	pounds.
Fat	12.03	"
Carbohydrates	21.77	"

The Comparative Digestibility of Wheat Bran and Wheat Middlings.

The wheat bran (shorts,) which is at the present time one of our most important commercial cattle foods, is quite different mechanically and chemically, we may believe, from that produced by the earlier processes of milling, being coarser and more nitrogenous. The mechanical difference is apparent to the eye, while the change in composition is seen by comparing earlier analyses with those given in this report. The average content of protein in eight samples of bran analyzed by Storer and Johnson* previous to 1877, is given below in comparison with the average of the samples collected last winter by this Station.

	Range of per cent. of protein.	Average per cent. of protein.
Storer & Johnson, eight analyses,	11.13% to 13.91%	12.87%
This Station, six analyses,	16.38% to 17.69%	16.89%

Armsby† has previously called attention to the difference between roller bran and that produced in former years.

The only digestion experiments with wheat bran which are recorded were made in Germany, and there seems to be no evidence than the experimental food was similar to our roller bran. In fact, there is every reason to believe that the majority of the German tests were made with quite different material. The digestibility of middlings does not seem to have been determined anywhere, at least the German tables of digestion coefficients make no mention of this feeding stuff, though it is possible that the term bran (Kleie) has been applied to material which in this country would be called middlings. It seems reasonably certain, however, that there is here recorded the first determination and comparison of the digestibility of American roller bran and middlings.

Plan of Experiment. The animals used were wethers, as in former experiments, and the general method of procedure was the same as heretofore observed. The determination of the digestibility of a grain or other concentrated food by ruminants requires a modification of the plan followed in the case of a hay, for the reason that a sheep cannot well be fed on bran alone, or corn alone. It seems to be necessary to feed a fodder such as hay with

* See Bulletin I, Bussey Institute, and Report of Conn. Agricultural Experiment Station, 1877.

† See Report of Wis. Experiment Station, 1885, p. 86.

the concentrated food to be tested, the digestibility of this hay having been determined by previous experiments with the same animals. In this case Red Top hay was fed with both the middlings and bran. The daily rations were as follows:

Sheep 1 and 2 $\begin{cases}\text{400 grs. Red Top Hay}\\ \text{400 grs, middlings}\end{cases}$ Sheep and 3 4 $\begin{cases}\text{400 grs.RedTop Hay}\\ \text{400 grs. bran.}\end{cases}$

When the digestion experiment previously recorded was begun, a much larger lot of Red Top hay was cut and mixed than was used in that experiment, and this surplus was again sampled and weighed out for use in the middlings and bran experiment. A quantity of middlings was thoroughly mixed, from which the rations were weighed and samples taken. The bran was similarly treated.

Analytical data. The analyses of the second sample of Red Top and of the middlings and bran gave the following figures:

	In 100 parts air-dry substance.						In 100 parts water-free substance.				
	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
	%	%	%	%	%	%	%	%	%	%	%
XCIII, Red Top Hay	10.07	4.50	8.18	25.73	48.17	3.35	5.00	9.09	28 61	53.57	3.73
XCII, Fancy Midulings	11.13	3.04	20.0[illegible]	5.73	57.03	4.01	3.42	22.57	5.32	64.18	4.51
XCI, Bran	11.55	6.03	16.56	8.06	53.31	4.41	6.84	18.72	9.11	60.28	5.05

The necessary analyses of the feces were also made.

Composition of the Feces.

FROM	Water.	Dry substance.	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
Red Top and Middlings, Sheep 1...	70.8	29.2	10.20	12.62	25.97	47.66	3.55
" " " " 2...	70.7	29.3	10.11	13.20	25.76	47.26	3.67
Red Top and Bran, " 3...	75.1	24.9	12.34	11.02	25.09	48.38	3.17
" " " " 4...	71.3	28.7	12.49	9.96	25.86	48.57	3.12

Weights of Food Eaten and Feces Excreted.

	Total food eaten in five days.		Total feces excreted in five days.	
	Air-dry.	Water-free.	Fresh.	Water-free.
	grams.	grams.	grams.	grams.
Experiment with Wheat Middlings.				
Sheep 1. XCIII, Red Top..............	2000	1798.6	4021	1176.2
Sheep 1. XCII, Wheat Middlings......	2000	1777.4		
Sheep 2. " " "	"	"	3730	1094.6
Experiment with Wheat Bran.				
Sheep 3. XCIII, Red Top.............	2000	1798.6	5865	1459.6
Sheep 3. XCI, Wheat Bran...........	2000	1769		
Sheep 4. " " "			4780	1373.6

Digestibility of Wheat Middlings and Wheat Bran.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
XCII Wheat Middlings.							
Sheep 1.							
Fed in hay in five days	1798.6	1708.7	89 93	163.49	514.58	963.51	67.08
Fed in middlings in five days....	1777.4	1716.7	60.68	401.16	94.56	1140.74	80.16
Total fed..............................	3576.0	3425.4	150.61	564.65	609.14	2104. 5	147 24
Excreted in feces in five days.........	1176.2	1056.2	119.98	148.44	305.46	560.58	41.76
Total digested.........................	2399.8	2369.2	3[illegible].63	4 6.21	303.68	1543.67	105.48
Digested from hay......................	1109.7	1079.4	30.2[illegible]	101.65	315.49	622.81	38.09
Digested from middlings................	1290.1	1289.8	.36	314.46		920.86	67.39
Per cent. digested from middlings....	72.6	75.1		78.4		80.7	84.1
Sheep 2.							
Total fed.........	3576.0	3425.4	150.61	564.65	609.14	2104.25	147.24
Excreted in feces......................	1094.6	984.0	110.66	144.48	281.96	507.30	40.16
Total digested.........................	2481.4	2441.4	39.95	420.17	327.18	1586.95	107.08
Digested from hay......................	1109.7	1079.4	30.27	101.65	315.49	622.81	38.09
Digested from middlings........	1371.7	1362.0	9.68	318.52	11.69	964.14	68.99
Per cent. digested from middlings....	77.2	79.3		79.4		84.5	86.1
Average % digested by 2 animals.......	**74.9**	**77.2**		**78.9**		**82.6**	**85.1**
XCI Wheat Bran.							
Sheep 3.							
Fed in hay in five days................	1798.6	1708.7	89.93	163.49	514.58	963.51	67.08
Fed in bran in five days...............	1769.0	1648.	121.	331.16	161.16	1 66.35	89.33
Total fed..............................	3567.6	3356.7	210.93	494.65	675.74	2029.86	156.41
Excreted in dung in five days..........	1459.6	1279.5	180.12	160.84	366.22	706.16	46.26
Total digested...................... ...	2108.	2077.2	30.81	333.81	309.52	1323.70	110.15
Digesed fro m hay........	1109.7	1079.4	30.27	101.65	315.49	622.81	38.09
Digested from bran....	998.3	997.8	.54	232.16		700.89	72.06
Per cent. digested from bran..........	56.4	60.5		70.1		65.7	80.7
Sheep 4.							
Total Fed..	3567.6	3356.7	210.93	494.65	675.74	2029.86	156.41
Excreted in feces......................	1373.6	1202.	171.56	136.82	355.22	667.14	42.86
Total digested.........................	2194.0	2154.7	39.37	357.83	320.52	1362.72	113.55
Digested from hay......................	1109.7	1079.4	30.27	101.65	315.49	622.81	[illegible]8.09
Digested from bran.	1084.3	1075.3	9.10	256.18	5.03	739.91	75.46
Per cent. digested from bran..........	61.3	65.2		77.3		69.4	84.5
Average % digested by 2 animals.......	**58 8**	**62.8**		**73.7**		**67.5**	**82.6**

There appears to be a marked difference in the digestibility of middlings and roller bran, as shown by the results of this experiment. A direct comparison of the two sets of figures is interesting.

	Coefficients of Digestibility				
	Dry substance.	Organic matter.	Protein.	Nitrogen-free extractive matter.	Fat.
Fancy Middlings....................	74.9	77.2	78.9	82.6	85.1
Roller Bran....	58.8	62.8	73.7	67.5	82.6
Difference......	16.1	14.4	5.2	15.1	2.5

Result of Experiment.

(1.) This roller bran appears to have been slightly less digestible than the Alsike clover or early-cut Timothy hay.

(2.) In this experiment the digestible organic nutritive material in a fine sample of middlings and in roller bran was found to have the relation of 123 to 100. In other words, sheep digesting their food as they did in this experiment would get as much nutriment from 100 pounds of the middlings as from 123 pounds of bran.

(See further on for feeding experiment with middlings and bran.)

Composition and Digestibility of Pea Meal.

Peas are one of our most highly nitrogenous vegetable foods, as is shown by numerous analyses. The number of analyses of peas made in this country is very small so far, however, and it is worth while to inquire a little more fully into the composition of the American product.

The peas, the analysis of which follows, and which were used in the digestion experiments herewith described, were bought in the Bangor market under the name of Canada Peas, being a small, smooth variety. Their composition is stated below:

	Water.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.	In 100 parts water-free substance. Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
XCVIII. Pea Meal	12.48	2 36	23.50	2.53	57.69	1.44	2.69	26.85	2.89	65.92	1.64

In the case of this particular lot of peas over one-fourth of the dry substance consists of nitrogenous material, which is more than twice the amount found in corn meal, a fact that points to peas as a Maine product well adapted to feeding young animals or milch cows.

Digestibility of Peas. During the period that Sheep 3 and 4 were being fed for the determination of the digestibility of Southern Corn Ensilage, Sheep 1 and 2 were fed daily, 1500 grams of the same ensilage and 400 grams of pea meal. The digestibility of the ensilage being ascertained by the use of the first-named sheep, it becomes possible to calculate the digestibility of the peas in the latter case, the usual data being obtained.

Composition of the Feces.

FROM	Fresh feces		In 100 parts water-free substance.				
	Water.	Water-free substance	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
	%	%	%	%	%	%	%
Sheep 1.							
Southern Corn Ensi age and Pea Meal.......	72.33	27.67	13.13	20.09	21.57	41.51	3.70
Sheep 2.							
Southern Corn Ensilage and Pea Meal.......	74.95	25.05	12.90	22.70	19.89	40.92	3.59

Weights of Foods Eaten and Feces Excreted.

	Food eaten in five days.		Feces excreted in five days.	
	As fed.	Water-free.	Fresh.	Water-free.
	grams.	grams.	grams	grams.
Southern Corn Ensilage, Sheep 1..........	7500	1333.9	2499	692
Pea Meal, Sheep 1........................	2000	1750.4		
Southern Corn Ensilage, Sheep 2.........	7500	1333.9	3000	751.6
Pea Meal, Sheep 2........................	2000	1750.4		

DIGESTIBILITY OF PEA MEAL.

	Dry substance.	Organic matter.	Ash.	Protein Nx6.25.	Fiber.	Nitrogen-free extractive matter.	Fat.
XCVIII, Pea Meal.							
Sheep 1.							
Fed in Ensilage in five days.	1333.9	1254.3	79.23	136.32	427.51	652.68	38.15
Fed in Pea Meal in five days	1750.4	1703.3	47.08	469.98	50.59	1153.86	28.71
Total Fed	3084.3	2957.6	126.31	606.30	478.10	1806.54	66.86
Excreted in feces in five days	692.1	601.2	90.86	139.02	149.26	287.24	25.60
Total Digested	2392.2	2356.4	35.45	467.28	328.84	1519.30	41.26
Digested from Ensilage	843.2	831.6	11.84	63.56	315.70	428 21	24.91
Digested from Pea Meal	1549.0	1524.8	23.61	403.72	13.14	1091.09	16.35
Per cent. digested from Pea Meal	88.5	89.5	50.2	85.9	26.00	94.5	56.9
Sheep 2.							
Total Fed	3084.3	2957.6	126.31	606.30	478.10	1806.54	66.86
Excreted in feces in five days	751.6	654.6	96.96	170.62	149.50	307.56	26.98
Total Digested	2332.7	2303.0	29.35	435.68	328.60	1498.98	39.88
Digested from Ensilage	843.2	831.6	11.84	63.56	315.70	428.21	24.91
Digested from Pea Meal	1489.5	1471.4	1 .51	372.12	12.90	1070.77	14.97
Per cent. digested from Pea Meal	85.1	86.4	37.2	80.5	25.5	92.8	52.1
Avg. per cent. digested by 2 animals	**86.8**	**87.9**	**43.7**	**83.2**	**25.7**	**93.6**	**54.5**

Result of Experiment.

In this experiment nearly nine-tenths of the dry substance of the peas was digested. This result, considered in connection with their composition, coincides with previous tests in showing that peas take a high standard as a cattle food, especially as compared with those foods which are the possible products of Maine farms.

FEEDING EXPERIMENTS.

MISCELLANEOUS.

The Value of the Digestible Matter of Good Hay as Compared with the Digestible Matter of Corn Ensilage, for Milk Production.

During the past year and a half an accurate record has been kept of the yield and composition of milk from several cows owned and fed by the station. Any changes in the amount and quality of the milk, due to changes in the food, it has been possible to detect, therefore. The food has also been carefully weighed, and in some instances its composition and digestibility have been determined.

The direct object of this work has been a study of the products of several breeds, but the data collected allow conclusions to be drawn in regard to other matters of interest. The food of these cows has for the most part consisted of hay and a mixture of cotton-seed meal, bran and corn meal, but in the spring of 1888, for about two months a portion of the hay was replaced by ensilage. It was noticed that after the cows had been eating the ensilage for a day or two, there was a sudden and unmistakable increase in the yield of .milk, and as marked a decrease was observed when the ensilage was taken from the ration.

To what were these changes due? Did the hay alone contain less digestible material than the hay and ensilage combined? It was the intention to feed practically the same amount of digestible matter after the ensilage was added to the ration, as was eaten before. If this was done, then we must grant that in this case a pound of digestible substance from corn ensilage was somewhat superior to the same amount of digestible substance from good hay. Let us study the evidence which the data furnish.

The ensilage was fed from March 8th, 1888, to May 10th, 1888, inclusive. From March 8th to April 8th, the ensilage fed was that from the field corn, after which date the sweet corn ensilage was eaten, excepting the last five days, when a change was made to

southern corn ensilage. The amount of grain eaten was the same before, during and after the ensilage.

The cows whose records are given in this connection are the following:

Jansje 2d, Holstein, 6 years; last calf June 7th, 1888; due to calve Aug. 25th, 1889.

Queen Linda, Ayrshire, 4 years; last calf Oct. 11th, 1888; due to calve Nov. 13th, 1889.

Agnes, Jersey, 8 years; last calf Sept. 8th, 1888; due to calve Sept. 11th, 1889.

Ida of Beech Grove, Jersey, 4 years; last calf Aug. 26th, 1888; due to calve Aug. 28th, 1889.

The following figures show the weekly yields of milk from the four cows from Feb. 17th to May 25th inclusive, a period of time extending from three weeks before, to two weeks after the feeding of the ensilage.

JANSJE.

YIELD OF MILK.

		lbs.	oz.	
Hay 27 lbs.	Feb. 17 to Feb. 23	196	6	milk.
Grain 8 lbs.	Feb. 24 to March 2,	195	5	"
	March 3, to March 9,	197	6	"
	Total yield, (21 days)	589	1	"
	Average daily yield,	28.05 lbs.		

		lbs.	oz.	
Hay 16.7 lbs.	Mar. 10 to Mar. 16,	215	8	milk.
Ensilage 41.7 lbs.	Mar. 17 to Mar. 23,	214	4	"
Grain 8.0 lbs.	Mar. 24 to Mar. 30,	213	6	"
	Mar. 31 to Apr. 6,*	167	2	"
	Apr. 7 to Apr. 13,	203	3	"
	Apr. 14 to Apr. 20,	204	10	"
	Apr. 21 to Apr. 27,	182	13	"
	Apr. 28 to May 4,	183	11	"
	May 5 to May 11,	176	5	"
	Total yield, (63 days)	1759	14	"
	Average daily yield	27.9 lbs.		

		lbs.	oz.	
Hay 28 lbs	May 12 to May 18,	162	2	milk.
Grain 8 lbs.	May 19 to May 25,	147	1	"
	Total yield, (14 days)	309	3	"
	Average daily yield	22.08 lbs.		

* Jansje was sick for two or three days during this time, and failed to eat well.

QUEEN LINDA.

YIELD OF MILK.

		lbs.	oz.	
	Feb. 17 to Feb. 23,	182	12	milk.
Hay 24.6 lbs.	Feb. 24 to Mar. 2,	173	8	"
Grain 7.0 "	Mar. 3d to Mar. 9,	180	0	"
	Total yield, (21 days)	536	4	"
	Average daily yield	25.5 lbs.		

		lbs.	oz.	
	Mar. 10 to Mar. 16,	185	0	milk.
	Mar. 17 to Mar. 23,	182	13	"
	Mar. 24 to Mar. 30,	179	2	"
Hay 14.9 lbs.	Mar. 31 to Apr. 6,	178	3	"
	Apr. 7 to Apr. 13,	179	4	"
Ensilage 40 lbs.	Apr. 14 to Apr. 20,	177	6	"
	Apr. 21 to Apr. 27,	165	1	"
Grain 7 lbs.	Apr. 28 to May 4,	166	15	"
	May 5 to May 11,	163	4	"
	Total yield, (63 days)	1577	0	"
	Average daily yield	25 lbs.		

		lbs.	oz.	
	May 12 to May 18,	155	0	milk.
Hay 23.3 lbs.	May 19 to May 25,	150	7	"
Grain 7.0 lbs.	Total yield, (14 days)	305	7	"
	Average daily yield	21.8 lbs.		

AGNES.

YIELD OF MILK.

		lbs.	oz.	
	Feb. 17 to Feb. 23,	149	2	milk.
Hay 26.1 lbs.	Feb. 24 to Mar. 2,	143	6	"
	Mar. 3 to Mar. 9,	155	4	"
Grain 7.0 lbs.	Total yield, (21 days)	448	12	"
	Average daily yield	21.4 lbs.		

		lbs.	oz.	
	Mar. 10 to Mar. 16,	160	2	milk.
	Mar. 17 to Mar. 23,	164	6	"
	Mar. 24 to Mar. 30,	164	0	"
Hay 15.1 lbs.	Mar. 31 to Apr. 6,	165	2	"
	Apr. 7 to Apr. 13,	170	9	"
Ensilage 40 lbs.	Apr. 14 to Apr. 20,	173	5	"
	Apr. 21 to Apr. 27,	166	4	"
Grain 6 lbs.	Apr. 28 to May 4,	167	2	"
	May 4 to May, 11,	162	1	"
	Total yield (63 days)	1512	15	"
	Average daily yield	24 lbs.		

		lbs.	oz.	
	May 12 to May 18,	157	0	milk.
Hay 25.6 lbs.	May 19 to May 25,	147	14	"
Grain 6 lbs.	Total yield, (14 days)	304	14	"
	Average daily yield	21.8 lbs.		

IDA OF BEECH GROVE.

YIELD OF MILK.

Feed	Period	lbs.	oz.	
Hay 22.7 lbs.	Feb. 17 to Feb. 23	83	14	milk.
Grain 6 lbs.	Feb. 24 to Mar. 2	81	8	"
	Mar. 3 to Mar. 9	85	14	"
	Total yield, (21 days)	251	4	"
	Average daily yield	12 lbs.		

Feed	Period	lbs.	oz.	
Hay 13.5 lbs.	Mar. 10 to Mar. 16	87	15	milk.
Ensilage 33.3 lbs.	Mar. 17 to Mar. 23	86	10	"
Grain 6 lbs.	Mar. 24 to Mar. 30	88	12	"
	Mar. 31 to Apr. 6	90	7	"
	Apr. 7 to Apr. 13	91	9	"
	Apr. 14 to Apr. 20	94	5	"
	Apr. 21 to Apr. 27	93	10	"
	Apr. 28 to May 4	93	2	"
	May 5 to May 11	87	9	"
	Total yield, (63 days)	813	15	"
	Average daily yield	12.9 lbs.		

Feed	Period	lbs.	oz.	
Hay 25.6 lbs.	May 12 to May 18	91	12	milk.
Grain 6.0 lbs.	May 19 to May 25	86	10	"
	Total yield (14 days)	178	6	"
	Average daily yield	12.7 lbs.		

The average yields of the four cows for the three periods are placed together so as to render comparison easier.

	Daily yield on hay and grain, February 17th to March 9th.	Daily yield on hay, ensilage and grain, March 10th to May 11th.	Daily yield on hay and grain, May 12th to May 25th.
Jansje	28.05 lbs	27.9 lbs	22.08 lbs.
Queen Linda	25.5 "	25. "	21.8 "
Agnes	21.4 "	24. "	21.8 "
Ida	12. "	12.9 "	12.7 "
Average,	21.74 lbs.	22.45 lbs.	19.6 lbs.

These figures show that during the time when ensilage was fed, 63 days, the cows maintained an average yield somewhat greater than from the previous exclusive hay and grain feeding, even though a decrease in milk flow would ordinarily have taken place. When a return is made from hay and ensilage to hay alone, a sudden and decided drop in production occurs.

The effect of the ensilage in the ration is more clearly seen perhaps by comparing the production of milk for the last fourteen days before, and the first fourteen days after feeding ensilage, and the last fourteen days before and the first fourteen days after stopping the ensilage ration.

YIELD OF MILK.

	Jansje.		Queen Linda.		Agnes.		Ida.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Last 14 days before feeding ensilage, Feb. 24th to March 9th.	392	11	353	8	298	10	167	6
First 14 days after feeding ensilage, March 10th to March 23d.	429	12	367	13	324	8	174	9
Last 14 days of feeding ensilage, April 28th to May 11th.	360	0	330	3	329	3	180	11
First 14 days after stopping ensilage ration, May 12th to May 25th.	309	3	305	7	304	14	178	6

The somewhat favorable effect of the ensilage in the milk yield is unmistakable. Did the milk change in quality, so that the ensilage merely caused a larger quantity of milk with no increase of milk solids? The evidence of the analyses in regard to this point is conclusive.

	Jansje.		Queen Linda		Agnes.		Ida.	
	Solids %	Fat %	Solids %	Fat %	Solids %	Fat %	Solids %	Fat %
Feb. 25th to March 1st.	12.55	3.46	12.62	3 27	15.13	5.08	15.88	5.84
April 1st to April 1st.	12.58	3.48	12.87	3.49	15.42	5.38	16.02	5.93
April 29th to May 3d.	12.49	3.43	12.69	3.42	15.48	5.19	16.04	6.03
June 3d to June 7th.	13.23	3.71	13.04	3.44	14.98	4.96	16.95	6.45

It is seen that the milk had practically the same composition while the ensilage was fed as before, the slight changes that did occur, being generally in favor of the ensilage, so that we may safely conclude that after March 10th there was an increased production of milk solids.

To what is this larger production due? The grain ration remained the same, so we need to inquire whether hay alone contained more or less digestible matter than the hay and ensilage combined.

The digestibility of the ensilage was ascertained by experiments with sheep, already described. It was scarcely possible to obtain the digestibility of an average sample of all the hay eaten for nearly four months, so the best that can be done is to assume that the hay fed to the cows, which was the earliest cut and was very largely Timothy, had practically the same digestibility as the

early-cut Timothy, taken from the same field during the same season, the composition and digestibility of which are previously given.

The hay is assumed to have had 12.5 per cent. moisture and 4.5 per cent. of ash, or 83 per cent. of organic matter, and the ensilage had on the average 16 per cent. of organic matter. The organic matter of the hay and of the ensilage had a digestibility of 61 per cent. and 71* per cent. respectively.

These data furnish the following average quantities of digestible matter consumed, excepting that of the grain, which was the same throughout.

	Digestible matter eaten daily in Hay and in Hay and Ensilage.			
	Jansje.	Queen Linda.	Agnes.	Ida.
Feb. 17 to March 9. — *Hay.*	13.67	12.44	11.79	11.49
March 10 to May 11 — *Hay....*	8.45	7.54	7.64	6.83
March 10 to May 11 — *Ensilage*	4.73	4.54	4.54	3.78
March 10 to May 11 — *Total...*	13 18	12.08	12.18	10.61
May 12 to May 25. — *Hay...*	14.17	13.21	.12.95	12.95

* Average for Field corn and Sweet corn.

The change from hay alone to hay and ensilage seems not to have increased, but rather slightly diminished the amount of digestible matter eaten. The outcome of the experiment seems to warrant the following remarks:

(1.) **In this experiment the addition of ensilage to the ration resulted in a somewhat increased production of milk solids, which was not caused by an increase in the digestible food material eaten, but which must have been due either to the superior value of the nutrients of the ensilage over those of the hay, or to the general physiological effect* of feeding a greater variety of foods. In other words 8.8 pounds of ensilage proved to be somewhat superior to 1.98 pounds of hay (mostly Timothy,) the quantity of digestible material being the same in the two cases.**

(2.) **Nevertheless, the testimony of such results as this experiment furnishes, sustains rather than destroys the general practical utility of the rule in making rations, that two fodders have a relative value that is proportionate to their digestible material.**

* That such an effect is possible is somewhat problematical.

(3.) Assuming the digestible matter of hay and ensilage to be equal in value, pound for pound, when hay is worth $10 per ton, ensilage of the kind used in this experiment would be worth $2.25 per ton. But this ensilage contained more water than the average, or 83.3 pounds to the hundred, while the average fifty-seven American analyses is 80.5 pounds of water or 19.5 pounds of dry matter to the hundred.

Had this ensilage been of average quality, then the ton value reckoned on the above basis would be $2.62. But in this case we should give the ensilage the credit of the increased milk production, which seems to have been at the rate of 85 lbs. of milk to each ton of ensilage.

The Value of the Digestible Matter of Ensilage as Compared with the Digestible Matter of Hay, for Growth.

An experiment was carried on with young steers in the winter and spring of 1889, for the purpose of testing the value of ensilage in the ration, similar to the experiment with milch cows, just described. The plan of feeding was the same in the two cases. A change was made from a hay ration to a hay and ensilage ration, then from a hay and ensilage ration to a hay ration, with a final change back to hay, and ensilage in all, four periods. These periods were:

(1.) Jan. 4th to Feb. 23d, inclusive, Hay and Mixed Grains.
(2.) Feb. 24th to May 29th " Hay, Ensilage and Mixed Grains.
(3.) May 30th to June 27th " Hay and Mixed Grains.
(4.) June 28th to July 31st " Hay, Ensilage and Mixed Grains.

From Jan. 4th to March 30th, the grain ration was three pounds of mixed grains to each animal daily, and after that four pounds. The grains were the same in kind and mixed in the same proportions throughout. The amount of hay fed was adapted to the appetite of the animals, while twenty pounds of ensilage were fed daily to each steer during the entire experiment.

In order to secure the most accurate statement possible of the relative growth with and without ensilage, the amounts of food and grain are given, and comparisons are made for the following periods of time:

Jan. 4th to Feb. 23 is compared with Feb. 24th to March 27th.

April 29th to May 29th is compared with May 30th to June 27th. A part of Period 2 is left out of consideration, as it seems more accurate to compare closely contiguous periods of time. Period 4 is not mentioned, as during part of July the animals were so harassed by flies that their growth must have been greatly affected.

There can be seen below the weights of hay and ensilage eaten, both total and digestible, and the gain made by each animal during each period. The grain eaten is not stated, as it was the same in the periods compared.

As has already been shown the digestibility of the ensilage was determined by actual trials, as was also that of the hay fed from Jan. 4th to Feb. 23d, it being the Early and Late Cut Timothy, the composition and digestibility of which are given on pages 44 and 45 of this report. The hay fed during the other periods, was that cut during the first of the haying season, and was mostly Timothy, and so its digestibility is assumed to be the same as Early Cut Timothy grown the same year and harvested at nearly the same time. A description of the steers used in this experiment, with a fuller statement of their rations, weights, etc., will be found later. The data given in this connection are only a part of an experiment covering more than a year's time, the object of which was to compare the growth of different breeds, and only such facts are now stated as are needed for showing the effect of changing part of a hay ration for corn ensilage.

HAY, THREE POUNDS GRAIN DAILY.

Jan. 4th to Feb. 23d, 50 days.

	Hay eaten	Total digestible matter eaten in hay.	Digestible matter eaten daily in hay	Total Gain	Daily Gain
	lbs.	lbs.	lbs.	lbs.	lbs.
Steer 1	520.	263. *	5.26	92†	1.84
Steer 2	505.	255.5	5.11	78	1.56
Steer 3	493.	249 5	4.99	81	1.62
Steer 4	520.	263.	5.26	80	1.60
Steer 5	520.	263.	5.26	58	1.16
Steer 6	520.	263.	5 26	72	1.44
Totals,	3078.	1557.		461	

* The hay is assumed to have 83 per cent. of organic matter throughout.

† The weights of the Steers were found by averaging their weighings made on three consecutive days.

HAY AND FIELD CORN ENSILAGE. THREE POUNDS GRAIN DAILY.

Feb. 24th to March 27th, 32 days.

	Hay eaten	Ensilage eaten	Total digestible matter eaten in hay and ensilage	Digestible matter eaten daily in hay and ensilage	Total Gain	Daily Gain
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Steer 1.....	260.	634.	203.8	6.37	79	2.47
Steer 2.....	250.	581.	192.7	6.02	55	1.72
Steer 3.....	250.	611.	196.1	6.13	64	2.00
Steer 4.....	255.	619.	199.6	6.24	58	1.81
Steer 5.....	250.	584.	193.0	6.03	61	1.90
Steer 6.....	250.	513.	185.0	5.78	56	1.75
Totals,	1515.	3542.	1170.2		373	

HAY AND SOUTHERN CORN ENSILAGE. FOUR POUNDS GRAIN DAILY.

April 29th to May 29th, 31 days

	Hay eaten	Ensilage eaten	Total digestible matter eaten in hay and ensilage	Digestible matter eaten daily in hay and ensilage	Total Gain	Daily Gain
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Steer 1.....	290.	620.	223.	7.19	54	1.74
Steer 2.....	265.	620.	210.3	6.78	56	1.81
Steer 3....	250.	620.	202.8	6.54	64	2.06
Steer 4	270.	620.	212.9	6.87	65	2.09
Steer 5.....	270.	620.	212.9	6.87	55	1.77
Steer 6.....	265.	620.	210.3	6.78	60	1.93
Totals,	1610.	3720.	1272.2		354	

HAY. FOUR POUNDS GRAIN DAILY

May 30th to June 27th, 29 days.

	Hay eaten	Total digestible matter eaten in hay	Digestible matter eaten daily in hay	Total Gain	Daily Gain
	lbs.	lbs.	lbs.	lbs.	lbs.
Steer 1..............	410.	207.4	7.15	49	1.69
Steer 2..............	390.	197.3	6.80	56	2.00
Steer 3..............	380.	192.3	6.63	40	1.38
Steer 4..............	395.	199.9	6.89	70	2.48
Steer 5..............	390.	197.3	6.80	50	1.72
Steer 6..............	390.	197.3	6.80	40	1.38
Totals,	2355.	1191.5		305	

SUMMARY.

	Length of feeding periods days.	Total hay eaten by six steers.	Total ensilage eaten by six steers.	Total digestible matter eaten by six steers in hay and ensilage.	Average digestible matter eaten daily by each steer in hay and ensilage.	Total gain of six steers.	Daily average gain of each steer.
HAY.*		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Jan. 4th to Feb. 23d	50	3078		1557.	5.19	461	1.54
HAY AND ENSILAGE.*							
Feb. 24th to Mar. 27th	32	1515	3542	1170.2	6.09	373	1.94
HAY AND ENSILAGE.†							
Apr. 29th to May 29th	31	1610	3720	1272.2	6.84	354	1.90
HAY.†							
May 30th to June 27th	29	2355		1191.5	6.84	305	1.75

* With 3 lbs. grain daily.
† With 4 lbs grain daily.

In comparing the growth from Jan. 4th to Feb. 23d on hay and grain with that made from Feb. 24th to Mar. 27th, on hay, ensilage and grain, we find a more rapid gain during the latter period. We also find that in the second period the animals each ate about a pound a day more of digestible matter than in the first period, which is sufficient to account for at least a part of the increased growth, as the ratio of food to live weight was somewhat larger in this period. The ratio of digestible food to growth was practically the same in the two cases.

In the case of the later periods, Apr. 29th to May 29th, and May 30th to June 27th, in passing from a ration of hay, ensilage and grain to one of hayand grain, there was a small decrease in the rate of gain, while the amount of digestible material consumed per day remained unchanged.

In regard to this experiment comparing hay and ensilage in feeding for growth, we are warranted in saying:

(1.) A pound of digestible matter from the corn ensilage produced somewhat more growth than a pound of digestible matter from Timothy hay. The difference was small, however, amounting in the case of the last two periods, where the more accurate comparison is possible, to an increased growth of only 15 pounds of live weight for each ton of ensilage fed.

(2.) If no account is made of this difference in nutritive effect, one pound of hay proved to be equal to 4.1 pounds of ensilage, of the kind fed.

(3.) The experiment furnishes still further evidence that the amount of digestible matter present may be regarded as a safe basis for comparing the feeding value of foods of the same class.

General Remarks Concerning Ensilage and Other Succulent Foods.

There is one question which is very commonly asked when ensilage, roots and similar cattle foods are discussed from the standpoint of their composition and digestibility, viz: "Have not those foods a value which the chemist's figures do not show?" The real meaning of this question is that there is a belief on the part of many that because a cattle food is green and has never been dried it has a peculiar value not found in hay and grain, and so ought not to be "weighed in the balance" and judged by the impartial and searching logic of mathematics which is applied to foods of a different class. Scientific men, and many observing men of practice, have never shown this notion much favor. It is a cardinal principle in science, expressed in homely phrase, that "you cannot get something from nothing."

Growth, muscular activity and animal heat are effects which must have equivalent causes. They are the direct products of matter and energy stored in the food, and the animal cannot get out of a ration more pounds of matter or units of force or heat than are actually in it, nor can the farmer by any magic of combinations or treatment of foods do more than make available their maximum nutritive value.

It should always be remembered that greenness and wetness add nothing to what a food can supply to the animal body of matter or energy, other things being equal, but are merely conditions affecting palatableness. It is the digestible dry matter of a food that determines its value.

It has been demonstrated repeatedly that carefully dried grass is as digestible after as before drying, and the same of fodder corn dried and as ensilage. Dryness is therefore no disadvantage in this respect. Such experiments as those just discussed, show, moreover, that a pound of digestible matter in ensilage with its accompanying seven or eight pounds of water can do only practi-

cally the same work as a pound of digestible material from Timothy hay with its water nearly all dried out. There is a small difference in favor of the ensilage, to be sure, and an absolutely hard and fast equivalance, pound for pound, is not claimed in comparing even foods of the same class, because one food may be superior to another in the amount of the more valuable carbohydrates found in the digested portions. But after making an allowance for these minor points which cannot be expressed or even recognized in a general rule, there is still room for the assertion that Science has given Practice no safer or more useful conclusion than this: *Cattle foods have nutritive value in proportion to the digestible dry matter which they contain.* If farmers will apply this rule in studying feeding stuffs, especially in comparing fodders with fodders, and grains with grains, they will avoid mistakes of a serious nature. But after this is done, there is still a chance for the exercise of good judgment in combining foods.

An Experiment in Feeding Early and Late Cut Timothy Hay, for Growth.

On pages 44 and 45 of this report are given the composition and digestibility of two lots of Timothy hay, cut on July 9th and July 24th. One lot was cut while in bloom, and the other after the seeds were quite fully formed.

Over a ton of hay was harvested from each cutting, or enough for a feeding experiment. Six steers from six to nine months old were used to test the relative value of the hay. The experiment covered two periods of time, one from Dec. 7th to Jan. 3d, inclusive, and the other from Jan. 4th, to Feb. 13th inclusive. Late-cut hay was fed during the first and Early-cut during the second period. Three pounds of grain were fed each day to each animal, during both periods. The hay was readily and entirely consumed throughout the experiment and the animals maintained a very satisfactory condition, also.

The figures which show the result of the experiment follow.

LATE CUT HAY.

Period 1.—Dec. 7th to Jan. 3d, 28 days.

	Total hay eaten*	Total digestible matter eaten in hay	Digestible matter eaten daily in hay by each steer	Total gain of each steer	Daily gain of each steer
	lbs.	lbs.	lbs.	lbs.	lbs.
Steer 1..........	266.5	131.3	4.7	48	1.71
Steer 2...........	266.5	131.3	4.7	37	1.32
Steer 3...........	262.	129.2	4.3	37	1.32
Steer 4...........	266.5	131.3	4.7	33	1.18
Steer 5...........	266.5	131.3	4.7	57	2.03
Steer 6...........	266.5	131.3	4.7	35	1.25
Totals,	1594.5	785.7		247	

* The amount of grain fed being the same during both periods, and the only variation in the ration being in the kind of hay, it is not necessary to take the grain into account in discussing the outcome of the experiment.

EARLY CUT HAY.

Period 2.—Jan. 4th to Feb. 13th, 41 days.

	Total hay eaten	Total digestible matter eaten in hay	Digestible matter eaten daily in hay by each steer	Total gain of each steer	Daily gain of each steer
	lbs.	lbs.	lbs.	lbs.	lbs.
Steer 1...........	410.	206.2	5.0	66	1.61
Steer 2...........	395.	198.7	4.8	57	1.39
Steer 3...........	385.	193.6	4.7	67	1.63
Steer 4...........	410.	206.2	5.0	62	1.51
Steer 5...........	410.	206.2	5.0	53	1.29
Steer 6...........	410.	206.2	5.0	63	1.54
Totals,	2420.	1217.1		368	

SUMMARY.

	Total hay eaten by six steers.	Total digestible matter in hay eaten.	Total gain of six steers.	Daily average gain of each steer.	Pounds of hay fed with each pound of grain.	Pounds of digestible matter of hay with each pound of gain.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Period 1, 28 days, Late-cut hay......	1594.5	785.7	247	1.47	6.45	3.18
Period 2, 41 days, Early-cut hay....	2420.	1217.1	368	1.49	6.58	3.30

So far as an experiment of this kind can furnish reliable evidence, we have reason to believe that there was practically no difference in the feeding value of this two lots of hay. This is what might be expected after finding that the hay had so little difference in composition and digestibility, and may be considered as adding to the constantly accumulating evidence that the relative value of fodders can be ascertained quite closely without an actual feeding trial.

It is rarely the case, however, that early and late-cut hays show so little difference in composition and digestibility, and so the result here recorded should not be considered as representative.

An Experiment for Comparing the Feeding Value of Wheat Middlings and Wheat Bran.

The values of wheat middlings and wheat bran, when judged by composition alone, do not seem to be greatly different. As proof of this, the average composition of seven samples of middlings and six samples of bran as given on page 59 of this report, are cited here.

	Water.	Ash.	Protein.	Fiber.	Nitrogen-free extractive matter.	Fat.
Wheat middlings	11.25	3.01	16.98	4.16	60.80	4.35
Wheat bran	11.50	6.33	16.86	7.92	52.81	4.58

A determination of the digestibility of the middlings and bran with sheep (see page 64 of this report) revealed the fact that as much was digested from 100 lbs. of middlings as from 123 lbs. of bran. This indicated quite a difference in feeding value, and it only remained to test the matter by ascertaining whether in an actual feeding trial with these two foods growth would be obtained in proportion to the digestible matter which they seemed to furnish. There were used for this feeding trial four swine weighing about 200 lbs. each. Previous to the time when this experiment began these animals had been eating a ration of skimmed milk and corn

meal, and they were in a very thrifty condition. The four animals were divided into two lots, and one lot ate bran while the other lot ate middlings. The experiment was continued during twc peirods, and the order in which these foods were fed in the first period was reversed in the second, this being done so as to test the growth of each pair of hogs with both middlings and bran.

The figures which follow show that the amount of food eaten was not the largest possible, moderate rations being considered essential to those experiments whose especial object is the testing of the relative nutritive value of foods.

It is hoped that the figures stated below plainly show how the hogs were fed and the result of the experiment.

PERIOD 1.

June 20th to July 20th, 31 days.

	LOT A.	LOT B.
Wheat bran fed daily,	5 lbs.	
Total bran eaten	155 "	
Wheat middlings fed daily		5 lbs.
Total middlings eaten		155 "
Skimmed milk eaten daily	20 "	20 "
Total skimmed milk eaten	620 "	620 "
Weight of hogs on June 18th and 19.	398 "	386¾ "
Weight of hogs on July 19th and 20,	422½ "	425¼ "
Gain of each lot in 31 days,	24½ "	38½ "

PERIOD 2.

July 21st to Aug. 30th, 41 days.

	LOT A.	LOT B.
Wheat bran fed daily to Aug. 5th.		6 lbs.
" " " " Aug. 6th to Aug. 30th,		6½ "
Total bran eaten,		258½ "
Wheat middlings fed daily to Aug, 5th.	6 lbs.	
,, middlings fed daily Aug. 6th to Aug. 30,	6½ "	
Total middlings eaten.	258½ "	
Skimmed milk fed daily to Aug. 5,	16 "	16 "
Skimmed milk fed daily Aug 6th to Aug. 30,	10 "	10 "
Total skimmed milk eaten	506 "	506 "
Weight of hogs on July 19th and 20.	422½ "	425¼ "
Weight of hogs on Aug 29th and 30th,	494 "	454½ "
Gain of each lot in 41 days,	71½ "	29¼ "

SUMMARY OF BOTH PERIODS.

Gain of two hogs in 72 days on $\left\{\begin{array}{l}\text{413½ lbs. middlings,}\\ \text{1126 " skimmed milk,}\end{array}\right\}$ 110 lbs.

Gain of two hogs in 72 days on $\left\{\begin{array}{l}\text{413½ lbs. bran,}\\ \text{1126 " skimmed milk.}\end{array}\right\}$ 53¾ lbs.

The growth obtained from feeding the middlings is clearly much greater than that produced by the bran. The explanation of this fact is not hard to find. From the data previously given, and estimating the skimmed milk to have ten per cent. of solids, practically all of which are digestible, we find that the animals eating middlings consumed in the 72 days 377 lbs. of digestible material, while those eating bran received only 317 lbs., the difference being 60 pounds. In other words, the middlings fed hogs ate 19 per cent. more digestible matter than the bran fed, though the weight of food was the same in the two cases, which means that the animals eating the middlings had available just so much more of nutrients to be applied to growth.

The results of this experiment combined with the facts previously brought out, seem to establish the superior feeding value of wheat middlings as compared with wheat bran.

Summary of Comparison of Wheat Middlings and Wheat Bran.

(1.) The middlings and bran sold in Maine do not at present differ greatly in composition, the bran containing somewhat more ash and somewhat less of carbohydrates.

(2.) In a trial with sheep, the middlings were found to be much more digestible than bran, the ratio of digestibility being as 123 to 100 in the two cases.

(3.) A feeding trial with swine, where very moderate rations of both middlings and bran were fed in connection with skimmed milk, the growth from the middlings ration was over twice that from the bran ration, or in the ratio of 110 to 53.

FEEDING EXPERIMENTS WITH SWINE.

The feeding experiments that have been carried on at this Station during the past two years have largely invloved the use of swine as the experimental animals. It should not be assumed from this that the hog is regarded as of unusual importance in Maine agriculture. Pork production must certainly rank in this State much below the dairy or stock growing,but it is, nevertheless, a matter of general interest, for on each farm more or less swine are grown either for home consumption or for sale. Moreover, swine are useful in consuming and converting into a cash product, the waste materials from the dairy.

Again, experiments in pig feeding are in some respects especially satisfactory as compared with those conducted with milch cows or steers, for the reason that there is much less uncertainty due to the daily variations in weight of the experimental animals. The weights of a thousand pound steer taken on two consecutive days may differ as much as ten or fifteen pounds, whereas the weight of a growing pig will uniformily increase by approximately the amount of growth. Conclusions based upon the relative growth of swine fed upon different rations seem therefore to be especially safe, and so a test of a theory of nutrition by the use of these animals may promptly give a definite answer, which may have a practical bearing not only upon the matter of pork production but upon production of other kinds as well.

The feeding experiments with swine which are grouped together on the following pages have been going on during the past two years, and are now published for the first time. The publication of the earlier experiments has been delayed until they could be discussed in connection with the later ones now just completed, because they are all more or less related in purpose. These experiments were planned and begun with the idea of illustrating the feeding value of skimmed milk, but as one question after another has arisen, they have been enlarged and modified until they have furnished testimony bearing upon several points important from both the scientific and practical standpoints. These points stated somewhat in the language of science are:

(1.) The most efficient ratio of nutrients in a ration.

(2.) The relation between the nutritive ratio and the character of the growth.

(3.) The equivalence of different classes of nutrients.

(4.) The relative value of animal and vegetable protein.

(5.) The effect of much water in the food upon assimilation.

Let us translate the above considerations, with others, into the language of the farm.

(1.) The most profitable mixture of foods for swine.

(a) For growth.

(b) For fattening.

(2.) The relation between food and growth with swine.

(3.) Can we substitute nitrogenous vegetable foods like pea meal or gluten meal for skimmed milk, with equally good results?

(4.) Does a large amount of drink, as in the case of swill fed pigs, for instance, diminish growth?

(5.) The relative food value of skimmed milk and corn meal.

(6.) The money value of skimmed milk.

The experiments from which data are drawn for the discussion of the above points have involved the use of twelve swine, six lots, two animals in a lot, and were carried on at various times during nearly eighteen months. In the case of four of the animals, two lots, the record kept of their food and growth was continuous from the young pigs to the marketed product.

The animals were fed three times per day, and unless otherwise specified, the meal or other dry material was wet with the drink. A small amount of bone meal was put into the food two or three times each week, so that with none of the rations should there be a lack of mineral compounds for bone formation. Only one case of lameness occurred, and that was one of the animals of Lot 3, when quite mature, and during one of the least important periods.

It was the intention, when feeding two lots of pigs with different rations for the purpose of comparing the growth obtained, to give the same amount of digestible material to each lot. In order to make the estimates necessary for doing this it was assumed (1) that the skimmed milk contained ten per cent. of solids, all of which was digestible, and (2) that equal weights of pea meal, gluten meal and corn meal supplied equal weights of digestible material. These assumptions would not have been admissable in an investigation demanding rigid exactness, but they are consistent with the conclusions attempted. As a matter of fact, occasional analyses of the skimmed milk and an analysis and actual determination of the digestibility of one lot of peas fed make it seem reasonably certain that any errors of calculation due to these

assumptions emphasize, rather than otherwise, some of the principal lessons of the experiments.

It would have required a large amount of time and labor to have ascertained the composition and changes in the water content of the numerous lots of corn meal fed during nearly a year and a half, and it was felt that the purposes of the experiments did not require this. There is so great a degree of uniformity in the composition of Western corn that a large error is not probable in assuming that the average of several lots will agree with the general average of composition and digestibility.

Experiment with Lots 1 and 2.

The feeding of the four pigs in these two lots was begun in June 9th, when they weighed less than twenty-five pounds each, and was continued until the animals were slaughtered in the following February. For the first seventy-seven days, or until August 24th, both lots were fed a mixture of skimmed milk and corn meal, the skimmed milk supplying two-thirds the digestible matter with Lot 1, and one-third, with Lot 2, the total amount of digestible matter in the ration being the same in the two cases. After August 24th, the proportion of milk to meal was changed, somewhat, and after October 27th, Lot 2 ate nothing but corn meal and water. Lot 1 continued to eat milk until December 20th, after which date this lot was given a ration consisting of one-third pea meal and two-thirds corn meal. Until October 27th, the gain of the two lots of pigs was practically the same, but from that time on there was a marked difference in favor of Lot 1. These pigs were from the same litter, and the lots were similar as to sex. The figures giving a history of this experiment have been arranged in a tabular form below:

Daily Rations of Pigs.
Lots 1 and 2.

	Lot 1.				Lot 2.			Change in weight.	
	lbs. Water.	lbs. Skimmed milk.	lbs. Corn meal.	lbs. Pea meal.	lbs. Water.	lbs. Skimmed milk.	lbs. Corn meal.	lbs. Lot 1.	lbs. Lot 2.
June 9th to June 29th....		8	½			4	1	47¾ to 71½	49 to 64½
June 30th to July 26th....		12	¾			6	1½	71½ to 102½	64½ to 93
July 27th to Aug. 24th....		16	1			8	2	102½ to 130	93 to 123
Aug. 25th to Sept. 14th....		20	1¼			8	2¾	130 to 157	123 to 154½
Sept. 15th to Sept. 29th....		20	2½		3	5	4¼	157 to 180½	154½ to 177½
Sept. 30th to Oct. 27th....		20	5		3	5	6¾	180½ to 247	177½ to 237
Oct. 28th to Nov. 20th....		25	7		12		10	247 to 323½	237 to 301
Nov. 21st to Dec. 20th....		30	11¼		15		15	323½ to 453½	301 to 408½
Dec. 21st to Jan. 19th....	15		10	5	15		15	453½ to 577	408½ to 500
Jan. 20th to Feb. 19th....	15		8⅔	4⅓	15		13	577 to 690	500 to 552

Food Eaten and Growth Made by Pigs.

Lots 1 and 2.

Period 1. *Food of both lots, skimmed milk and corn meal. Each lot ate the same amount of digestible material, more of which came from skimmed milk with Lot 1 than with Lot 2.*

		Lot 1.			Lot 2.		
		Milk eaten.	Corn meal eaten.	Gain in weight.	Milk eaten.	Corn meal eaten.	Gain in weight.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
June 9th to June 29th,	21 days	168	10½	23¾	84	21	15½
June 30th to July 26th,	27 days	324	20¼	31	162	40½	28½
July 27th to Aug. 24th,	29 days	464	29	27½	232	58	30
Aug. 25th to Sept. 14th,	21 days	420	26¼	27	168	57¾	31½
Sept. 15th to Sept. 29th,	15 days	300	37½	23½	75	63¾	23
Sept. 30th to Oct. 27th,	28 days	560	140	66½	140	189	59½
Totals,	141 days	2236	263½	199¼	861	430	188

Period 2. *Food of Lot 1, skimmed milk and corn meal, and of Lot 2, water and corn meal. Each lot ate the same amount of digestible material.*

		Lot 1.			Lot 2.		
		Milk eaten.	Corn meal eaten.	Gain in weight.	Milk eaten.	Corn meal eaten.	Gain in weight.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Oct. 28th to Nov. 20th,	24 days	600	168	76½		240	64
Nov. 21st to Dec. 20th,	30 days	900	337½	130		450	107½
Totals,	54 days	1500	505½	206½		690	171½

PERIOD 3. *Food of Lot 1, water, pea meal and corn meal, and of Lot 2, water and corn meal. Both lots ate the same amount of digestible material.*

	Lot 1.			Lot 2.		
	Pea meal eaten.	Corn meal eaten.	Gain in weight.	Milk eaten.	Corn meal eaten.	Gain in weight.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Dec. 21st to Jan. 19th. 30 days..	150	300	123½		450	91½
Jan. 20th to Feb. 19th, 31 days..	134	269	113		403	52
Totals, 61 days	284	569	236½		853	143½

EXPERIMENTS WITH LOTS 3 AND 4.

Two experiments were performed with these pigs, but they were of such a nature that one experiment did not unfit the animals for the succeeding one. The animals of the two lots were from the same litter, and of corresponding sex. They weighed at the beginning of the first experiment an average of thirty-eight pounds each. From Nov. 2d to March 1st they were fed alike on skimmed milk and corn meal, and Lot 4 drank in addition an amount of water equal in weight to the skimmed milk. From March 2nd to May 28th the skimmed milk in the ration of Lot 3 was replaced by pea meal, but was continued in the ration of Lot 4. The growth of the two lots was practically the same throughout.

The tables immediately following give the result of these methods of feeding.

DAILY RATIONS OF PIGS.

LOTS 3 AND 4.

	Lot 3. lbs. Skimmed milk.	Lot 3. lbs. Corn meal.	Lot 4. lbs. Water.	Lot 4. lbs. Skimmed milk.	Lot 4. lbs. Corn meal.	Change in weight of pigs. lbs. Lot 3.	Change in weight of pigs. lbs. Lot 4.
Nov. 2nd to Nov. 20th......	5	2	5	5	2	76 to 99	76 to 96½
Nov. 21st to Dec. 8th......	8	2½	8	8	2½	99 to 117½	96½ to 116½
Dec. 9th to Jan. 10th......	10	4	10	10	4	117½ to 176	116½ to 171
Jan. 11th to March 1st......	15	5	15	15	5	176 to 276	171 to 266
	Pea meal.						
Mar. 2nd to Apr. 17th......	2½	5		20	5	276 to 360½	266 to 358
Apr. 18th to May 28th......	3	6		24	6	360½ to 450	358 to 447

FOOD EATEN AND GROWTH MADE BY PIGS.

LOTS 3 AND 4.

PERIOD I. *Food of both lots the same, only that Lot 4 was given twice as much drink as Lot 3.*

		Lot 3. Milk eaten.	Lot 3. Meal eaten.	Lot 3. Gain in weight.	Lot 4. Water given.	Lot 4. Milk eaten.	Lot 4. Meal eaten.	Lot 4. Gain in weight.
		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Nov. 2d to Nov. 20th,	19 days...	95	38	23	95	95	38	20½
Nov. 21st to Dec. 8th,	18 days...	144	45	18½	144	144	45	20
Dec. 9th to Jan. 10th,	33 days...	330	132	58½	330	330	132	54½
Jan. 11th to Mar. 1st,	50 days...	750	250	100	750	750	250	95
Totals,	120 days	1319	465	200	1319	1319	465	190

PERIOD 2. *Food of Lot 3, pea meal aud corn meal, and of Lot 4, skimmed milk and corn meal. Both lots ate the same amount of digestible material.*

	Lot 3.			Lot 4.			
	Pea meal eaten.	Meal eaten.	Gain in weight.	Water given.	Milk eaten.	Meal eaten.	Gain in weight.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Mar. 2d to Apr. 17th, 47 days...	117½	235	84½		940	235	92
Apr. 18th to May 28th, 41 days...	123	246	89½		984	246	89
Totals, 88 days	240½	481	174		1924	481	181

EXPERIMENTS WITH LOTS 5 AND 6.

Four pigs were again selected from a litter, and when they had reached a weight of over thirty pounds, the two lots into which they were divided began to receive radically different rations. Lot 5 was fed from Nov. 7th to Dec. 8th on skimmed milk, corn meal and potatoes, and Lot 6 on corn meal and potatoes. On Dec. 9th the skimmed milk in the ration of Lot 5 was replaced by pea meal, the materials of the rations of Lot 6 remaining unchanged, and this feeding was continued until March 26th.

It was realized before hand that it might be difficult to get a satisfactory development of the animals of Lot 6 with such a ration, and this proved to be the case, though the pigs seemed vigorous and healthy. It was found impossible to induce this lot to eat, without waste, more than a very moderate amount. Lot 5, on the contrary, would have eaten very much more than the ration allowed, even after the pea meal was substituted for the milk, but the food of this lot was limited to the amount fed to Lot 6. Considering the quantity of food eaten, the gain of Lot 5 was very satisfactory.

From March 26th until the following October, the pigs of Lots 5 and 6 were all fed on skimmed milk, bran and corn meal, and the animals of Lot 6 regained their lost ground, and reached practically the size and condition of Lot 5, their average live weight on Oct. 10th, being about 275 lbs. It was the intention at this time to have put these animals on the market, but as it was thought

they were not fat enough to sell to advantage, though in fair condition, it was decided to feed them for a time so that they would take on fat rapidly. The standard food for this purpose has always been corn meal, and is what many farmers would now use exclusively as a fattening ration. It was determined to test the wisdom of the practice with the case in hand. For a time Lot 5 was fed a mixture of gluten meal and corn meal, and Lot 6 was fed pure corn meal. For a second period this order of feeding was reversed, Lot 5 receiving the pure corn meal. The advantage of the mixed ration was too marked to be doubted for an instant, as the record below shows.

Daily Rations of Pigs.
Lots 5 and 6.

	Lot 5.				Lot 6.			Changes in weight of pigs	
	lbs. Water drank.	lbs. Skimmed Milk.	lbs. Corn Meal.	lbs. Potatoes.	lbs. Water drank.	lbs. Corn Meal.	lbs. Potatoes.	lbs. Lot 5.	lbs. Lot 6.
Nov. 7th to Nov. 20th		6	1¼	2	6	2	2	69½ to 84½	61½ to 70
Nov. 21st to Dec. 8th		8	2	3	8	3	3	84½ to 113	70 to 84½
		Pea Meal							
Dec. 9th to Jan. 10th	10	1⅓	2⅔	4	10	4	4	113 to 160½	84½ to 121½
Jan. 11th to Jan. 19th	12	2	4	4	12	6	4	160½ to 271½	121½ to 175
Jan. 20th to Mar. 26th	12	1⅔	3⅓	4	12	5	4		

Food Eaten and Growth Made by Pigs.
Lots 5 and 6.

Period 1. *Food of Lot 5, skimmed milk, corn meal and potatoes, and of Lot 6, corn meal and potatoes. Both lots ate the same amounts of digestible material.*

	Lot 5.				Lot 6.		
	Milk eaten.	Corn meal eaten.	Potatoes eaten.	Gain in weight.	Corn meal eaten.	Potatoes eaten.	Gain in weight.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Nov. 7th to 20th 14 days..............	84	17½	28	15	28	28	8½
Nov. 21st to Dec. 8th, 18 days..........	144	36	54	28½	54	54	14½
Total 32 days......................	228	53½	82	43½	82	82	23

PERIOD 2. *Food of Lot 5, pea meal, corn meal and potatoes, and of Lot 6, corn meal and potatoes. Both lots ate the same amount of digestible material.*

	Pea meal eaten	Corn meal eaten	Potatoes eaten	Gain	Corn meal eaten	Potatoes eaten	Gain
Dec. 9th to Jan. 10th, 33 days........	44	88	132	47½	132	132	37
Jan. 11th to Mar. 26th, 75 "	128	256	300	111	384	300	53½
Totals............108 "	172	344	432	158½	516	432	90½

DAILY RATIONS OF HOGS.

LOTS 5 AND 6.

	Lot 5.			Lot 6.			Changes in weight.	
	lbs. Water drank.	lbs. Corn Meal.	lbs. Gluten Meal.	lbs. Water drank.	lbs. Corn Meal.	lbs. Gluten Meal.	lbs. Lot 5.	lbs. Lot 6.
Oct. 13th to Nov. 12th......	20	8	4	20	12		552½ to 651	548½ to 624½
Nov. 13th to Nov. 20th......	20	10	5	20	15		651 to 668	624½ to 640
Nov. 21st to Dec. 28th......	20	15		20	10	5	668 to 765	640 to 769½

FOOD EATEN AND GROWTH MADE BY HOGS.

LOTS 5 AND 6.

PERIOD 3. *Lot 5 ate gluten meal and corn meal, and Lot 6, corn meal. The same weight of food was eaten in the two cases.*

	Lot 5.			Lot 6.	
	Gluten meal eaten.	Corn meal eaten.	Gain in weight.	Corn meal eaten.	Gain in weight.
	lbs.	lbs.	lbs.	lbs.	lbs.
Oct. 13 to Nov. 12, 31 days..........	124	248	98½	372	76
Nov. 13 to Nov. 20, 8 days..........	40	80	17	120	15½

PERIOD 4. *Lot 6 ate gluten meal and corn meal, and Lot 5, corn meal. The same weight of food was eaten in the two cases.*

	Lot 6.			Lot 5.	
Nov. 21, to Dec. 28, 38 days..........	190	380	129½	570	97
Totals, ...77 days..........	354	708	245	1062	188½

The Nutritive Ratio.—The Profitable Mixture of Foods.

These feeding experiments with swine offer some very direct and emphatic testimony bearing on that much discussed problem in the feeding of farm animals, viz. the nutritive ratio. This is the problem: Should a farmer take into consideration the composition as well as the price of cattle foods? Can he by purchasing an oil meal instead of corn meal, get a combination of foods with sufficiently greater food value, pound for pound, to warrant paying more for the oil meal than the corn meal would cost? In short, of the foods available to the farmer, is one combination better than another?

These questions relate to an important matter, and one concerning which farmers get great variety of advice. They are told on the one hand to adhere to the formulas known as the German rations, and on the other hand to buy what costs least per pound.

The following figures, the result of a close analysis of the data of these swine-feeding experiments, furnish the inquirer with facts relating to this matter that may need some explanation, but no emphasizing. They are the outcome of a careful test of a theory, and being the answer which several animals have given to a definite question, they deserve unprejudiced consideration.

TABLE SHOWING THE GROWTH OF SWINE WITH VARIOUS FOOD COMBINATIONS.

			Age of pigs.	Average weight of two pigs.	Kind of Food Eaten.	Total digestible matter eaten. Protein	Carbohydrates.	Fats.	Total.	No. of days in periods.	Total gain of two animals.	Daily gain of two animals.	Digestible matter eaten daily.	Digestible matter for each pound of gain.	Nutritive ratio.
				lbs.		lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	
Lots 1 and 2.	Period 1.	Lot 1	2 to 6 mos.	147.4	S. milk and corn meal	93.3	289.1	17.6	400	141	199¼	1.41	2.84	2.08	1:3.6
		Lot 2	2 to 6 mos.	142.4	S. milk and corn meal	63.7	331.7	19.2	414.6	141	188	1.33	2.94	2.21	1:6.0
	Period 2.	Lot 1	6 to 8 mos.	350	S. milk and corn meal	93.7	420.9	25.2	539.9	54	206½	3.81	10.00	2.61	1:5.2
		Lot 2	6 to 8 mos.	322.8	Corn meal	59.3	463.1	26.2	548.6	54	171½	3.18	10.10	3.20	1:8.9
	Period 3.	Lot 1	8 to 10 mos.	571.8	Pea meal and corn meal	107.6	510.8	24	672.4	61	236½	3.87	11.00	2.85	1:5.6
		Lot 2	8 to 10 mos.	480	Corn meal	73.3	571.8	33	678.1	61	143½	2.35	11.10	4.73	1:8.9
Lots 3 and 4.	Period 1.	Lot 3	2 to 6 mos.	176	S. milk and corn meal	83.5	384.6	22.9	491	120	200	1.66	4.09	2.45	1:5.3
		Lot 4	2 to 6 mos.	171	S. milk and corn meal	83.5	384.6	22.9	491	120	190	1.58	4.09	2.58	1:5.3
	Period 2.	Lot 3	6 to 9 mos.	363	Pea meal and corn meal	91.1	457.4	20	568.5	88	174	1.98	6.46	3.26	1:5.6
		Lot 4	6 to 9 mos.	356½	S. milk and corn meal	112.5	424.8	27.9	565.2	88	181	2.06	6.42	3.12	1:4.4
Lots 5 and 6.	Period 1.	Lot 5	2 to 3 mos.	91	S. milk, corn meal and potatoes	13.5	63.7	2.9	80.1	32	43½	1.34	2.51	1.84	1:5.2
		Lot 6	2 to 3 mos.	72	Corn meal and potatoes	8.4	70	3.5	81.9	32	23	.72	2.56	3.56	1:9.4
	Period 2.	Lot 5	3 to 7 mos.	192	Pea meal, corn meal and potatoes	72.1	407.6	14.3	494	108	158½	1.47	4.57	3.12	1:6.1
		Lot 6	3 to 7 mos.	129	Corn meal and potatoes	51.3	427.4	19.6	498.3	108	90½	.84	4.61	5.50	1:9.3
	Period 3.	Lot 5	13 to 14 mos.	610	Gluten meal and corn meal	69.2	307.4	20.3	396.9	39	115½	2.96	10.20	3.44	1:5.2
		Lot 6	13 to 14 mos.	594	Corn meal	42.3	330.1	18.7	391.1	39	91½	2.35	10.00	4.27	1:8.9
	Period 4.	Lot 5	14 to 15 mos.	716	Corn meal	49	382.5	21.6	453.1	38	97	2.50	11.90	4.70	1:8.9
		Lot 6	14 to 15 mos.	709	Gluten meal and corn meal	80.2	356.1	23.5	459.8	38	129½	3.41	12.00	3.55	1:5.2

The experimental feeding of these six lots of swine included nine periods, varying in length from 32 to 141 days. In six of these periods the food of the lots of pigs whose growth was compared differed greatly in the nutritive ratio, or in other words, in the relation in quantity of the digestible protein to the digestible carbohydrates and fats. The ration of one lot of pigs in each of the six cases contained the equivalent of from 5.2 lbs. to 6.1 lbs. of digestible carbohydrates for each pound of digestible protein, and with these combinations the average daily gain of two pigs was 2.81 lbs.,the quanity of digestible food required for one pound of grain being 2.90 lbs. The corresponding lots of pigs in each of the six periods ate less protein and more carbohydrates, the ratio being 8.9 lbs to 9.4 lbs. of digestible carbohydrates to one pound of digestible protien. Here the gain of two pigs averaged only 1.99 lbs. per day, 4.33 lbs. of digestible material being used for each pound of grain. The pigs eating the smaller amount of protein consumed about 50 per cent. more digestible food for each pound of growth than did the others.

Now these comparisons of rations were made with swine of various ages and conditions, from young growing pigs to large hogs that were being fattened. Consequently each period or comparison may profitably be considered separately, for while the general average is largely in favor of the rations containing most protein, a closer examination may show that what is true of young pigs does not hold for mature animals that are being fattened.

The feeding of the two lots of pigs, numbered 1 and 2, began when the animals were about two months old. For 141 days both lots ate skimmed milk and corn meal, Lot 1 eating more milk and less meal than Lot 2, the digestible matter being practically the same. The growth of the two lots differed but little on these rations, though the nutritive ratio in one case was 1 : 3.6, and in the other 1 : 6.0. The milk was then taken from the ration of Lot 2 and continued with Lot 1, and for the next 54 days the advantage was decidedly with Lot 1, these animals gaining 35 lbs. more than the others. During the third period of 61 days the corn meal ration of Lot 2 was continued, and pea meal was substituted for skimmed milk in the ration of Lot 1. In this period Lot 1 gained 93 lbs. more than Lot 2. The feeding of the animals of Lots 5 and 6 also began when they were young, but the rations compared differed more widely than was the case with Lots 1 and 2. For 32

days Lot 5 ate skimmed milk, corn meal and potatoes, and Lot 6 corn meal and potatoes, and the former animals made nearly twice the growth of the latter, the respective nutritive ratios being 1 : 5.2 and 1 : 9.4. Lot 5 was then put on a ration of pea meal, corn meal and potatoes, the materials of the food of Lot 6 remaining unchanged. Here the ratios were 1 : 6.1 and 1 : 9.3, and the gain of Lot 5 receiving the more nitrogenous ration, was in 108 days 68 lbs. more than the growth of Lot 6.

The pigs of Lots 5 and 6 were then not fed weighed rations for several months, the intention being to fit them for the market. During this time their food was milk, bran and meal. On the first of October these animals had reached an average live weight of 275 lbs., and it was decided to "finish them off" so that they would command the best market price. For this purpose it was determined to test a full ration of corn meal against one more nitrogenous. The food that was selected to combine with the corn meal was gluten meal, which is really a corn meal residue from which much of the starch has been extracted. This residue contains about three times as large a percentage of protein as corn meal. In this experiment the animals were given all they would eat readily, with one lot of hogs the food consisting of one-third gluten meal. In 77 days the gluten meal and corn meal mixture produced with two animals 57 lbs. more of fat hog than did the corn meal alone. This result may be relied on as involving no large error, for the experiment was so planned as to eliminate the effect of individual differences in the experimental animals. It is worthy of remark that the mixture of gluten meal and corn meal seemed to be fully as favorable to the production of fat as the clear corn meal.

The lesson of these several feeding tests with swine is that not only do nitrogenous foods exert a very favorable influence on growth, but they seem also to materially increase the rate of gain during the fattening periods.

What shall we conclude in the light of these experiments? Do these results encourage a farmer who has hogs to fatten, and who must buy food for that purpose, to purchase corn meal exclusively, simply because it costs less per pound than other concentrated foods? Certainly if there is any place where exclusive corn meal feeding is likely to prove satisfactory it is in the "ripening off" of hogs, and yet we see that for this purpose 172 lbs. of gluten meal not only took the place of that amount of corn meal but caused a

greater production of at least 50 lbs. of dressed pork. Allowing that the corn meal cost a cent a pound, the gluten meal gave returns at the rate of $48 per ton, which is nearly twice its cost* price. Pea meal is seen to have had an equally favorable effect with another lot of somewhat mature animals.

We must conclude that the way in which a farmer combines the foods at his command is a matter of great importance, and one that may determine whether some feeding operations shall result in profit or in loss.

The Relation Between the Kind of Food and the Character of the Growth Produced.

To what extent can we modify the composition of a hog's carcass by controlling the foods? Can we increase or decrease at will the proportion of lean meat to fat? Experiments by Professors Henry and Sanborn indicate that not only does a liberal proportion of nitrogenous food insure a more vigorous development of the hog, but the carcass contains a much larger proportion of muscular tissue (lean meat). In these experiments in Missouri and Wisconsin the rations differed radically, being on the one hand milk, blood and bran, and on the other corn meal alone. The rations fed to the pigs of Lots 1 and 2 at this Station differed in the same way but not to the same extent. The two lots of animals ate practically the same amount of digestible material, containing 294.6 pounds of digestible protein in one case and 196.3 pounds in the other. This difference was continuous throughout the entire life of the animals. To what extent were the carcasses of the two lots of hogs unlike? These hogs were slaughtered by an experienced butcher, who, with others, carefully inspected the meat, as seen by making sections of the carcasses. The various organs were weighed and also the intestinal fat and leaf lard. It is not claimed that this was anything more than a very superficial examination. Certainly the structure and composition of the animals might differ considerable and the fact not to be detected in this way. Such an inspection would only make evident any especial differences in those qualities of the meat that are of interest to the butcher and consumer.

Unmistakable differences of this kind did not appear, however. The fat portions of the carcasses were equally light colored and solid. The dealer who cut up the hogs thought that possibly the

* The gluten meal cost the station in small lots, $25 per ton in Bangor.

protein fed hogs would furnish him a slightly larger percentage of cuts of lean, but it was very evident after all that the pork resulting from rations so materially unlike differed mainly in quantity. Neither the butcher nor the consumer could see much chance for preference in the matter of quality. The testimony of the weights of the organs and internal fat coincides with the above statement.

	Lot 1. More protein.		Lot 2. Less protein.	
	Hog 1.	Hog 2.	Hog 3.	Hog 4.
Weight of carcass	283 lbs.	288 lbs.	234 lbs.	226 lbs.
" heart	15 oz.	13 oz.	14 oz.	12 oz.
" lungs	15 "	16½ "	12 "	13 "
" liver	78 "	54 "	43 "	51 "
" kidneys	10 "	12 "	7 "	7 "
" intestinal fat	148 "	117 "	132 "	107 "
" leaf lard	238 "	268 "	218 "	208 "

The internal fat of those animals which ate the larger proportion of nitrogenous food was 8.6 per cent of the weight of the carcass, and 9.0 per cent. in the case of the other animals, a difference that does not signify much. Of the organs weighed only the kidneys varied much in relative size. The results of this experiment are not put forward as conflicting with the teachings of experiments made elsewhere, but as showing that these unlike rations had more influence on the *amount* than on the *kind* of produce. The *kind* of produce is very largely determined by those constitutional characteristics that have become fixed by years of breeding, and unless the food is so one-sided as to be greatly abnormal, it undoubtedly may vary within quite wide limits during the life of a single generation without largely modifying the composition of the body which it builds up and nourishes. The effect of special feeding would be cumulative, doubtless, and after several generations we might expect a modification of product somewhat marked and persistent.

WHAT EXTENT OF VARIATION MAY OCCUR IN THE RELATION IN QUANTITY OF THE NITROGENOUS AND NON-NITROGENOUS CONSTITUENTS OF A RATION WITHOUT GREATLY AFFECTING THE RATE OF GROWTH?

A safe answer to this question would demand a large number of observations. Nevertheless the fact that the nutritive ratio may vary without affecting the rate of growth sufficiently to be determined by practical experiments is undoubted, and is well

illustrated in the experiments now under consideration. The pigs of Lot 1 grained 199 lbs. in the same time that the pigs of Lot 2 gained 188 lbs., the amount of digestible food being nearly the same, and the nutritive ratios being 1 : 3.6 and 1 : 6.0 respectively. In an eighty-eight day period with the animals of Lots 3 and 4 a nutritive ratio of 1 : 5.6 with Lot 3 did practically the same work as a ratio of 1 : 44 with Lot 4, the increase in weight being 174 and 181 lbs. in the two cases. It seems that in these feeding trials with swine, the various rations having a nutritive ratio of 1 : 6.1, or below, were equally efficient, and much more efficient than rations with a ratio of 1 : 9.0 or thereabouts. It is fair to conclude from this that in feeding for any particular purpose the proportion of protein must be kept up to a certain standard if the maximum results are to be attained, as a departure from this standard in the direction of less protein results in a diminished production. On the other hand, a deviation from this standard by increasing the proportion of protein seems to be without marked affect, within certain limits, at least. How shall we explain this? Let us suppose the ration is intended for a growing animal. A certain part of the new substance which constitutes growth consists of muscular tissue and other nitrogenous compounds, the only source of which is the protein of the food. Protein also plays a necessary, though unexplained, part in muscular activity. If, therefore, the the food is deficient in protein, growth must either be checked or become abnormal, and it is the former that is most likely to occur. But whenever a ration contains protein in excess of the *necessary* amount, the results are quite different. Although protein is the sole source of certain compounds essential to growth, it may and does perform other offices, such as the production of heat. When, therefore, the protein of the food is increased and the carbohydrates decreased, the former may furnish the fat or heat otherwise derived from the latter. To be sure the one class of compounds does not replace the other pound for pound. According to the estimates of physiological chemists a hundred parts of protein may furnish 51 parts, while the maximum product of one hundred parts of starch would be only 41 parts, of fat. The heat producing power of protein and of starch is not greatly different. These differences are not such, however, as to be easily detected by the crude methods of a practical experiment, and so there has sometimes been but little apparent effect from quite a wide variation of the nutritive ratio in past feeding trials.

The position of the writer in the matter of feeding formulas is this: The fact that protein has important and peculiar functions in the nutrition of animals that do not pertain to any other class of nutrients demands that a certain proportion of it shall be present in a ration, in order that growth shall not be restricted because of a lack of special building material. It is probable that few cases occur where it would not be profitable to supply protein to this extent. Whether more than this shall be fed, so that the albuminoids unnecessarily take the place of carbohydrates, is a matter that must be decided by the relative cost of different classes of foods.

THE RELATIVE VALUE OF ANIMAL AND VEGETABLE PROTEIN. CAN WE SUBSTITUTE NITROGENOUS VEGETABLE FOODS, LIKE PEA MEAL OR GLUTEN MEAL, FOR SKIMMED MILK, WITH EQUALLY GOOD RESULTS?

The efficiency of skimmed milk as food for swine has become proverbial. It is a nitrogenous food, its constituents are wholly digestible, or practically so, and it serves admirably as a supplement of the grain and other vegetable foods that are fed to swine. It is a question of some importance whether the farmer, who has no skimmed milk, or an insufficient supply, can fill its place with nitrogenous vegetable foods such as his farm or the market affords.

The verdict of these experiments is that it is not a question of skimmed milk, but of protein, and that skimmed milk can be successfully replaced by pea meal furnishing an equal quantity of digestible material.

In two instances pea meal was substituted for skimmed milk without any decrease in the rate of gain, and in one instance an amount of digestible matter from pea meal was fed against the same quantity from skimmed milk with practically equivalent results.

When the pigs of Lot 1 and 2 reached the age of eight months they were eating thirty pounds of skimmed milk and eleven and one-fourth pounds of corn meal. This ration was exchanged for one made up of five pounds of pea meal and ten pounds corn meal. The milk and meal ration contained 10 lbs. of digestible matter and caused a gain of 4.14 lbs. daily, while the latter ration supplied 11 lbs. digestible substance, the gain being 4.27 lbs. for the succeeding thirty days.

A similar exchange was made with animals of Lots 5 and 6,

when they were about three months old. The rate of gain con. tinued in this case to be satisfactory, and in marked contrast to that of the animals eating corn meal alone.

But the most accurate test of this question was with Lots 3 and 4 during a period of eighty-eight days. Both lots ate the same amount of corn meal, viz: 481 lbs. In addition to this Lot 3 consumed 240 1-2 lbs. of pea meal, and Lot 4, 1,924 lbs. of skimmed milk, it being estimated that these weights of pea meal and milk contained equal amounts of digestible material. The growth of Lot 3 was 174 lbs. and of Lot 4, 181 lbs., a difference of only seven pounds. In other words 568.5 lbs. of digestible matter, one-third of which came from pea meal, produced practically the same growth as 565.2 lbs. digestible matter, one third of which came from skimmed milk.

The Effect of the Amount of Drink Upon Growth

The results of certain past investigations are to the effect that excessive drink is prejudicial to growth or fattening, by causing increased protein or fat consumption in the body. Swill fed pigs or those eating skimmed milk exclusively, certainly take large quantities of drink. Is growth materially diminished, thereby? This Station has made a single experiment bearing on this point, the data of which are already given.

When the experiment began the animals averaged in weight 38 lbs. apiece. At the end of 120 days they weighed 135 lbs. apiece. During this time one lot of two pigs drank 1,319 lbs. of skimmed milk, and the other, 1,319 lbs. of milk and 1,319 lbs. of water, the meal ration being the same in the two cases. The amount of drink was at first 5 lbs. and 10 lbs., and these quantities were gradually increased. For the last 50 days of the experiment Lot 3 had 15 lbs. of drink daily and Lot 4, 30 lbs, this being at the rate of 3.6 quarts and 7.2 quarts for animals weighing during this period an average of 111 lbs. In the whole time of 120 days Lot 4 receiving the larger amount of drink gained 10 lbs. less than Lot 3, and in the last 50 days the difference was 5 lbs. in favor of Lot 3. The only safe assertion which can be made concerning the outcome of this experiment is that the difference in the amount of drink had no pronounced effect on the profits of feeding.

The Relative Value of Skimmed Milk and Corn Meal The Money Value of Skimmed Milk.

The estimation of the relative values of foods, or even their pecuniary value, on the basis of the results of experiments, is a matter of great difficulty. It is practically impossible to assign to cattle foods hard and fast relative values that hold under all circumstances. For instance, in these experiments skimmed milk gave *relative* returns quite unlike, according to the circumstances of feeding. In Period 1 of the experiment with Lots 1 and 2, 2,236 lbs. of skimmed milk and 263 1-2 lbs. of corn meal produced practically the same growth as 861 lbs. of skimmed milk and 430 lbs. of corn meal. Here 1,374 lbs. of skimmed milk did the same work as 166 1-2 lbs. corn meal, or one pound of meal proved to be approximately equal to eight pounds of milk. It is significant that the digestible matter is very nearly the same in these weights of milk and meal. When, however, the milk was withdrawn from the ration of Lot 2, the skimmed milk fed to Lot 1 not only replaced corn meal in the ratio of 8 to 1, but it should also be credited over and above this with the difference in growth of 2 1-2 lbs. of live weight for each 100 lbs. of milk fed.

Again in the experiments with the pigs of Lots 5 and 6, where Lot 5 was fed milk, meal and potatoes, and Lot 6 only meal and potatoes, eight pounds of milk took the place of one pound of meal, and caused an extra growth with two young pigs of 20 1-2 lbs. in thirty-two days, or at the rate of 9 lbs. of live weight for each 100 lbs. of milk fed.

In another case, Period 2, with the pigs of Lots 3 and 4, 1,924 lbs. of skimmed milk did the same work, practically, as 240 1-2 lbs of pea meal, which is exactly 8 lbs. of milk to one pound of pea meal.

Let us closely examine these several instances. In the first, much more milk was fed to one lot of animals than to the other. The two rations contained the same amount of digestible material and were equally efficient. In other words, the pigs eating the smaller quantity of milk had enough to give the ration its maximum efficiency, and the extra milk fed to the other animals simply took the place of so much corn meal, consequently it was worth only the price of corn meal, which was 12 1-2 cents for each 100 lbs. of skimmed milk, with meal at one cent per pound. If then, a farmer has some skimmed milk, enough to make up a third of

the digestible dry substance of the ration, for instance, whether he shall buy skimmed milk or corn meal to furnish part or all the rest of the ration must be decided by the cost of these articles of food. According to the Station experiments eight pounds of skimmed milk, will, under such circumstances make about the same growth as one pound of corn meal.

But if it is a question of feeding swine and *no* skimmed milk is furnished from the farm, then the farmer can afford to pay for *some* milk much more than a price corresponding to the cost of corn meal. The foregoing experiments show that a certain minimum amount of skimmed milk paid at the rate of twenty-five cents per hundred pounds, at least, with corn meal at one dollar per hundred, and peas at two dollars per hundred.

To sum up, corn meal is just as good as skimmed milk for part of the ration, and so far market values should determine which is to be used, but for the remaining part of the ration the milk has a special and superior value that may overrule the considerations of the market. The same would be true of any nitrogenous food that is needed to add a certain kind of strength to a ration.

Summary of Feeding Experiments With Swine.

(1.) The foregoing experiments teach that the profits of feeding swine may depend in part upon the way in which foods are combined, and not wholly upon market values. A certain proportion of nitrogenous foods like skimmed milk, pea meal and gluten meal increased the efficiency of the ration in a marked manner.

In six feeding periods where the rations compared contained practically the same digestible material, 2643 pounds of digestible food with a nutritive ratio* ranging from 1:5.2 to 1:6.1 produced 890 pounds of growth, while 2651 pounds of digestible food with a nutritive ratio varying from 1:8.9 to 1:9.4 produced 617 pounds of growth. It took nearly one-half more food to produce a pound of growth with one set of rations than with the other.

(2.) There seemed to be no advantage in putting into the rations more than a certain proportion of protein. A ratio of 1:6 was compared with one of 1:3.6, and one of 1:5.6 was compared with another of 1:4.4, the resulting growth being practically the same.

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* The *nutritive ratio* is the relation of the digestible protein to the digestible carbohydrates and fats. A ration having a nutritive ratio of 1:6 contains one pound of digestible protein to six pounds (or the equivalent) of digestible carbohydrates. A *narrow* ratio is one having much protein, and a *wide* ratio means a small proportion of protein.

(3.) The advantage of a nitrogenous food in the ration seems to pertain to the fattening period as well as to the period of growth. A mixture of pea meal and corn meal or of gluten meal and corn meal, proved to be greatly more efficient than corn meal alone in feeding animals already well grown and quite fat. The relative growth was from twenty to sixty per cent. in favor of the ration containing one of the nitrogenous foods. When we consider that over 70 per cent. of the weight added to the body of a fattening hog is fat, while only 6.5 per cent. is lean meat,* the favorable influence (at least indirect) of a liberal supply of protein upon fat production is very apparent.

(4.) Nitrogenous vegetable foods seemed to exert a favorable influence upon the growth of swine similar to that of skimmed milk. Moreover, the digestible matter of pea meal and of skimmed milk proved to have a nutritive value practically equivalent.

(5.) No marked effect was exerted upon growth by a wide variation in the amount of drink given to the two lots of animals. Pigs weighing but little over 109 pounds took approximately seven quarts of water daily and made but slightly less gain than animals of the same size drinking only half as much.

(6.) When skimmed milk is substituted for part of a ration of corn meal without changing the amount of digestible dry matter fed, the efficiency of the ration was greatly increased. A still further substitution of milk for meal appeared not to materially increase the rate of growth. For instance, a ration one third the nutrients of which were furnished by skimmed milk in a single trial proved to be worth practically as much as a ration two-thirds of the nutrients of which came from skimmed milk.

In the latter case some milk simply replaced corn meal in the ratio of 8 pounds of milk to 1 pound of meal, which is almost the exact ratio of equal quantities of digestible material.

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* Shown by Lawes & Gilbert with eighty animals.

TESTS OF SEVERAL BREEDS OF DAIRY COWS.—A STUDY OF DAIRY PRODUCTS.

In the spring of 1888 it was decided by those in control of this Experiment Station to undertake tests of different breeds of dairy cows. At that time the Director of this station addressed letters to quite a number of other stations suggesting co-operation in this line of work, as it seemed to him that in this way reliable business figures could be reached most quickly and satisfactorily. Although several stations were considering the matter of making such a test, there seemed to be quite a divergence of opinion, not only as to the practicability of such a scheme but also as to the methods to be adopted. Certainly no general desire was expressed to enter into this work in accordance with some uniform plan. Several stations are making these tests, however, and we may expect essentially the same class of facts to be brought out.

The first question to be considered was, Shall the test be made with a large or a small number of animals of each breed? It was decided to use two cows only of each kind, on the ground that two well selected typical animals should clearly show the prominent characteristics of the breed which they represent, and besides it was not possible to make a comprehensive study of the milk, butter and waste products of each cow, if any larger number of animals was used. The relation of milk, cream and butter, the waste of fat in the skimmed milk and butter milk, the effects of food, period of lactation and season upon the composition and other qualities of the milk, the reliability of the work of the chemist as a test of a cow's butter capacity, and the determination of what may properly constitute a butter standard, are points of supreme importance both in a study of breeds and in general dairy management, and the chemical and dairy work which they involve preclude the use of more than two or three animals of each breed.

The points studied which are more directly business considerations, are the following:

(1.) The cost of food.

(2.) The yield of milk, milk solids, fat, cream and butter, and the relations in quantity which these sustain.

(3.) The cost of milk, milk solids, fat, cream and butter, the food alone considered.

Many facts are being brought out in connection with this test which should be of interest to dairy men generally, viz.:

(4.) The composition of the whole milk.

(5.) The composition of the skimmed milk and butter milk.

(6.) The waste of fat in the skimmed milk and butter milk.

(7.) The effect of food and other conditions upon the availability (churnability) of the fat in the milk.

(8.) The relation of the fat in the milk and cream to the butter actually obtained.

These tests began in June 1888, and are still in progress. The results of only one year, June 1888 to 1889, are here reported for five animals. One of the Holsteins has not yet completed her first year's production and so no figures are given for her. This is really then, a report of progress.

It is to be distinctly understood that no single test of several breeds of dairy cows, especially of two animals of each breed, can determine the relative profits from their use; but notwithstanding this, such work has great value. Whatever of testing has been done in the past has mostly been done by the special advocates of each breed with a view to "booming" their business, and while our breeders of thoroughbred stock are as a rule men of high standing and undoubted integrity of character, it is quite probable, as they would doubtless confess, that they have more fully reported the production of phenomenal animals than of those of average capacity, and that tests of production have generally been made under a high pressure system of feeding and care which is very far removed from what is feasible in general practice. It is certainly well that a study of our dairy breeds by disinterested parties is being inaugurated at several stations, under uniform conditions, that are attainable in farm practice, and with animals as nearly representative as possible.

It is hardly probable that the consensus of the reports that will ultimately be made will do injustice to any breed, and we shall in this way come into possession of a mass of facts free from the bias of business interests, that will go far towards showing clearly what are the prominent characteristics, proper uses and present limitations of the breeds that are claiming attention as dairy animals.

THE ANIMALS USED AT THIS STATION.

The following are the six animals with which a dairy test is at present being conducted, a year's production from five of which is here reported.

They represent the Holstein, Ayrshires and Jerseys.

Jansje 2d, Holstein No. 3281, H. H. B., bred by P. Schenck, Wiernigerwaard, N. H., sire Graaf Adolf, Neth H. B. No. 98; Dam, Jansje, Neth, H. B. No. 672. Born January 1, 1882; weight, 1,275 lbs. Bought of F. W. Berry, New Gloucester, Me. Jansje dropped her first calf after coming to the station on June 7, 1888, and her second one on Sept. 2, 1889.

Agnes Smit, Holstein. (The records of this cow are not at hand for insertion here, but will be given later.)

Nancy Avondale, Ayrshire, No. 5539 A. B. Association. Bred by C. M. Winslow, Brandon, Vt. Sire Hebron No. 2083, dam Avis No. 4815. Born March 24, 1881; weight 1,050 lbs. Bought of C. M. Winslow, Brandon, Vt.

Nancy Avondale dropped a calf on Jan. 10, 1889, previous to coming to the Station in June. Her next calf was dropped March 25, 1889.

Queen Linda, Ayrshire, No. 8,497, A. B. Association. Bred by Alonzo Libbey, Saccarrappa, Me. Sire, Hebron, No. 2,083; Dam, Queen Lindetta, No. 6,190. Born Oct. 15, 1884; weight, 1,020 lbs. Bought of C. M. Winslow, Brandon, Vt. Queen Linda dropped a calf on Oct. 11, 1888, and again in Oct. 1889.

Agnes, Jersey, No. 834 M. S. J. B. Bred by Seth Andrews, Warren. Sire, Ike No. 376, M. S. J. H. B. Dam, Angie, No. 831, M. S. J. H. B. Born April 29, 1881, weight 870 lbs. Bought of C. G. Whitney, Thomaston, Me. Agnes dropped a calf on Sept. 8, 1888, and again on Sept. 13th, 1889.

Ida, of Beech Grove, Jersey, No. 466, M. S. J. H. B. Bred by C. G. Whitney, Thomaston, Me. Sire, Syringas, Lenox No. 340, M. S. J. H. B. Dam, Lena No. 473, M. S. J. H. B. Born Feb. 20, 1885, weight, 920 lbs. Bought of C. G. Whitney, Thomaston, Me. Ida dropped a calf on Aug. 26, 1888, and again on Aug. 28th, 1889.

FOOD OF THE COWS.

In feeding these cows, an effort has been made to adapt the food to their needs and appetite.

While the cows have been in milk they have received, excepting for a few weeks before parturition and for a short time after, the following grain rations:

Jansje,	8	lbs.	mixed	grain
Nancy Avondale,	7	"	"	"
Queen Linda,	7	"	"	"
Agnes,	6	"	"	"
Ida,	6	"	"	"

This grain was a mixture of two parts of corn meal, and one part each of cotton-seed meal and wheat bran, by weight For a time before and after parturition no cotton-seed meal has been fed, the amount of grain being diminished and made to contain a larger proportion of wheat bran.

The amount of hay fed was adapted more or less to the appetite of the cows, care being taken that the ration should be readily and completely eaten.

During two months of the spring of 1889 ensilage was fed in connection with the hay, fifty pounds being the maximum and forty pounds the minimum quantity eaten daily.

In the season of 1888 the cows were turned out to grass from June 6 to Sept. 22, and in 1889 from June 11 to Oct. 10. Excepting during June and part of July the cows ate more or less hay while at pasture. The grain ration was continued unchanged.

The next table gives the dates within which a year's trial of each cow was made, the total weights of food eaten, the length of time at pasture, and the average weights of food and time of pasturage reckoned for each of the three hundred and sixty-five days in the year.

FOOD EATEN BY COWS IN ONE YEAR.

	Jansje. (Holstein.) June 13, '88 to June 13, '89.	Nancy Avondale. (Ayrshire.) June 17, '88 to June 17, '89.	Queen Linda. (Ayrshire.) Oct. 20, '88 to Oct. 20, '89.	Agnes. (Jersey.) Sept. 18, '88 to Sept. 13, '89.	Ida. (Jersey.) Sept. 1, '88 to Sept. 1, '89.
	lbs.	lbs.	lbs.	lbs.	lbs.
Total hay eaten	6740	6375	5800	5600	5500
Total ensilage eaten	2670	1648	2540	2540	2540
Total cotton-seed meal eaten	524	250	486	459	427
Total corn meal eaten	1442	827	982	976	913
Total wheat bran eaten	724	778	748	616	605
Total food eaten in barn	12100	9878	10556	10191	9985
Days of pasturage	102	102	122	104	104
Hay eaten daily for 365 days	18.5	17.4	16.0	15.4	15.1
Ensilage eaten daily for 365 days	7.3	4.5	7.0	7.0	7.0
Grain eaten daily for 365 days	7.4	5.1	6.1	5.6	5 3
Pasturage daily for 365 days, hours	2.2	2.2	2.7	2.3	2.3

COST OF THE FOOD.

The foods which Maine farmers feed to their cattle generally comprise those grown on the farm and those purchased. In estimating the cost of feeding an animal, two methods are adopted, viz.: the home raised food is reckoned at what it costs to produce it and the purchased foods at cost price, or all the materials consumed, both home raised and purchased, are reckoned at what they are worth in the market.

The latter method is necessarily the one adopted here. If the Station had produced the háy and grain given to these experimental cows, it would have been both valuable and interesting to have kept a careful account with each crop for the purpose of ascertaining the actual cost of feeding farm animals from home raised foods. The method of adopting market prices answers every purpose in this case, however, as it is largely a question of comparative cost.

Again, the prices adopted must be somewhat arbitrary, as they always fluctuate during a year. An attempt has been made to approximate quite closely to the average market prices for the first year during which this test has been carried on.

The following are the prices used :

Hay, $10 per ton.
Cotton-seed meal, $28 per ton.
Corn meal, $20 per ton.
Wheat bran, $20 per ton.
Ensilage, $3 per ton.
Pasturage estimated for each cow.

Applying these prices to the quantities of hay, ensilage and grain found in the previous table, we have the figures below as the cost of keeping the cows one year. Any one who wishes to use different prices can make calculations that will apply to his peculiar conditions.

COST OF FOOD FOR ONE YEAR.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
Cost of hay	$33.70	$31.87	$29.00	$28.00	$27.50
Cost of cotton-seed meal	7.34	3.50	6.80	6.42	5.97
Cost of corn meal	14.42	8.27	9.82	9.76	9.13
Cost of wheat bran	7.24	7.78	7.48	6.16	6.05
Cost of ensilage	4.00	2.47	3.80	3.80	3.80
Cost of pasturage	6.50	6.00	7.00	5.50	5.50
Total cost for one year	$73.20	$59.89	$63.90	$59.64	$57.95

It may be asserted by some, and perhaps correctly, that by a different method of feeding these cows might have been kept more cheaply without diminishing production. But this work has not been carried on so far for the purpose of testing the comparative profits from various possible rations, and so the feeding has been done in accordance with the majority of practice of cattle feeders who give proper attention to the way in which the foods are mixed. There may be farmers so situated that they can feed the cows as well at a much smaller cost. Doubtless there are such, especially those who have such pasturage that the feeding of hay or grain from early summer to early autumn is at no time necessary. This question is not of importance, however, in this connection, and is only mentioned to prevent misunderstanding.

The Yield of Milk, Milk Solids, Fat, Cream and Butter.

The records kept of the production from these cows has been as follows:

The weights of milk from each milking; the weights of cream from each milking; the weights of cream at the time of churning; the weights of butter milk, and the weights of worked, unsalted butter.

The cream was raised in Cooley cans submerged in water having a temperature ranging from 42° F. to 45° F. The cans containing the several cows' milk have been set in the same cabinet, consequently the temperature has been the same for all. The cream has been measured in pounds. This has been done by carefully drawing off the skimmed milk and then the cream, the latter being weighed.

During a part of the year 1890 a record of cream will also be kept in inches, it having been suggested that the skimmed milk may not be drawn off with the same completeness in some cases as in others, and so the relative butter value of the cream from different cows may not be correctly ascertained by this method.

The yields of milk solids and pure fat are calculated from the amounts and composition of the milk.

The method of doing this is not to multiply the total yield of milk for the year by the average per centages. of solids and fat for the year, but to multiply each monthly yield or thereabouts by the corresponding per centages of solids and fats as determined for each month from the analysis of five consecutive days' milk.

The weights of solids and fats thus obtained must correspond very closely to the actual yield.

Table Showing Production from Cows for one Year.

	Jansje—Holstein.	Nancy Avondale—Ayrshire.	Queen Linda—Ayrshire.	Agnes—Jersey.	Ida—Jersey.
No. of days milked	365	281	287	340	322
Yield of milk	9991 lbs.	5948 lbs.	6983 lbs.	6876 lbs.	4107 lbs.
Yield of milk solids*	1227.7 "	751.1 "	893.6 "	1015.2 "	638.4 "
Yield of fat*	340.4 "	208.8 "	245.9 "	352 "	237.8 "
Yield of cream (fresh)	1819 "	1008 "	1008 "	1586 "	951 "
Weight of cream when churned	1763 "	971 "	947 "	1546 "	911 "
Yield of butter, (unsalted)	349½ "	197 "	188 "	379½ "	238 "
Average yield of milk per day during time milked	27.5 "	21.2 "	24.3 "	20.2 "	12.7 "

* The analyses of the milk from which these yields are calculated, are given on subsequent pages.

THE RELATION IN QUANTITY OF MILK, MILK SOLIDS, FAT, CREAM, AND BUTTER.

In the table below can be found information on the following points:

(1.) The quantity of milk required for one pound of milk solids.

(2.) The quantity of milk required for one pound of butter fat.

(3.) The quantity of milk required for one pound of cream.

(4.) The quantity of milk required for one pound of butter.

(5.) The quantity of cream required for one pound of butter.

	Jansje—Holstein.	Nancy Avondale—Ayrshire.	Queen Linda—Ayrshire.	Agnes—Jersey.	Ida—Jersey.
	lbs.	lbs.	lbs.	lbs.	lbs.
Milk for each pound milk solids.......	8.13	7.92	7.82	6.77	6.43
" " " fat....	29.35	28.49	28.40	19.52	17.27
" " " cream........ ..	5.49	5.90	6.92	4.34	4.32
" " " butter....	28.59	30.19	37.13	18.12	17.26
Cream for each pound butter..........	5.20	5.12	5.36	4.18	4.00

The fact of most importance that is shown by these figures is that the cows giving the poorest milk furnish the poorest cream. The butter value of the Jersey cream is twenty-five per cent. higher in these particular cases, than that from the Holstein and Ayrshires. It yet remains to be proved whether this difference would be maintained in cream from herds of these animals, and whether it will be equally plain when the cream is measured in inches and not by weight as drawn off.

Another point that is raised by dairymen is this: Has cream from cows fresh in milk the same value as that from cows approaching the time of parturition? The claim of some is that the butter value of cream is less at the latter time, and the data collected by the Station in this connection seem to substantiate this position, as can be seen by reference to the following figures:

Tables Showing the Butter Value of Cream at Different Times During the Period of Lactation.

JANSJE.

Jansje dropped a calf on June 7th, 1888, and again on Sept. 2nd, 1889.

	LBS.	OZ.
Cream from June 14th to July 4th, 1888,	122	1
Butter " " " " " " "	28	15
Ratio of butter to cream, 1 : 4.2		
Cream from Dec. 30th to Jan. 25th, 1889,	131	4
Butter " " " " " " "	26	12
Ratio of butter to cream, 1 : 4.9.		
Cream from May 20th to June 15th, 1889,	106	4
Butter " " " " " " "	20	8
Ratio butter to cream, 1 : 5.2.		

NANCY AVONDALE.

Nancy Avondale dropped a calf on Jan. 10th, 1888, and again on March 25th, 1889.

	LBS.	OZ.
Cream from June 18th to July 10th, 1888,	89	0
Butter " " " " " " "	19	5
Ratio butter to cream, 1 : 4.6		
Cream from Dec. 10th, 1888, to Jan. 6th, 1889,	62	6
Butter " " " " " " " "	12	0
Ratio butter to cream, 1 : 5.2.		
Cream from April 1st to 28th, 1889,	135	6
Butter " " " " " "	28	2
Ratio butter to cream, 1 : 4.8.		

QUEEN LINDA.

Queen Linda dropped a calf on Oct. 11th, 1888, and again in October, 1889.

	LBS.	OZ.
Cream from Oct. 22nd, to Nov. 18th, 1888,	143	3
Butter " " " " " " "	28	10
Ratio butter to cream, 1 : 4.8.		
Cream from Feb. 3rd to March 1st, 1889,	83	10
Butter " " " " " " "	17	14
Ratio butter to cream, 1 : 4.7.		
Cream from June 16th to July 14th, 1889,	72	4
Butter " " " " " " "	11	3
Ratio butter to cream, 1 : 6.5.		

AGNES.

Agnes dropped a calf on Sept. 8th, 1888, and again on Sept. 13th, 1889.

	LBS.	OZ.
Cream from Sept. 13th to Oct 5th, 1888,	98	0
Butter " " " " " " "	24	6
Ratio butter to cream, 1 : 4.0.		
Cream from Feb. 3rd to March 1st, 1889,	131	10
Butter " " " " " " "	32	14
Ratio butter to cream, 1 : 4.0.		
Cream from July 20th to Aug, 18th, 1889,	92	2
Butter " " " " " " "	19	8
Ratio butter to cream, 1 : 4.7.		

IDA.

Ida dropped a calf on Aug. 26th, 1888, and again on Aug. 28th, 1889.

	LBS.	OZ.
Cream from Sept. 1st to 23rd, 1888,	73	0
Butter " " " " "	18	12
Ratio butter to cream, 1 : 3.9.		
Cream from Feb. 3rd to March 1st, 1889,	74	2
Butter " " " " " " "	19	8
Ratio butter to cream, 1 : 3.7.		
Cream from June 3rd to 30th, 1889,	73	6
Butter " " " " " "	17	14
Ratio butter to cream, 1 : 4.1.		

Cost of Milk, Milk Solids, Fat, Cream and Butter.

In computing the cost of the production of these cows, the food is alone considered. Moreover, the cost given for the butter fat and butter represents the whole value of the food, no allowance being made for the other solids which are retained in the waste products from butter making, and which are certainly worth something. If there was a recognized market price for skimmed milk and butter milk, or if the skimmed milk of these animals was alike in value, in short, if an allowance made for the skimmed and butter milk could be anything but a purely arbitary estimate, relatively unfair in any case unless based upon the percentage of solids, it would be possible to calculate the case of butter on a different basis. As it is, each farmer must make his own estimate of the worth to him of the waste products of the dairy.

The following table of *costs* is calculated from the figures given in the two preceding tables :

	Jansje—Holstein.	Nancy Avondale—Ayrshire.	Queen Linda—Ayrshire.	Agnes—Jersey.	Ida—Jersey.
	cts.	cts.	cts.	cts.	cts.
Cost of milk per pound...........	.7326	1.0068	.9151	.8674	1.411
Cost of milk per quart*..........	1.56	2.16	1.96	1.86	3.02
Cost of milk solids per pound.....	5.96	7.97	7.15	5.87	9.08
Cost of fat per pound.............	21.50	28.68	25.58	16.94	24.39
Cost of cream per pound.........	4.02	5.94	6.34	3.76	6.09
Cost of cream per quart*.........	8.61	12.73	13.59	8.06	13.05
Cost of butter per pound.........	20.94	30.40	33.99	15.72	24.35

* The wine quart of 2 1-7 pounds. Cream really weighs slightly less.

Fifteen months elapsed between the times at which Jansje dropped her two calves since coming to the station, and as her year's test includes the first twelve months of this time her production was larger during that time though she had dropped a calf three months earlier, as would ordinarily have been the case. It is fair to expect that during her second year's trial she will produce less milk, and consequently at a greater cost. This will be determined later. It is worthy of note that the pound cost of the total milk solids differs less with the several cows than does the cost of the milk, cream or butter. The writer ventures the suggestion that the expense of producing milk will be found to depend not so much upon the yield by volume as upon the amount of dry matter it contains, other things being equal; or in other words, the milk that is worth least costs least. This is not strictly true in the station trials, though it is indicated.

The Relative Profits From Selling Milk, Cream or Butter.

The figures of the above table should be interesting to any farmers or others who are questioning as to the relative profits from selling milk, cream or butter, at the prices which they are able to command.

In the cases under consideration the amounts of milk, cream and butter from each cow are known, and it is possible, conse-

quently, to calculate the prices at which cream or butter should sell in order to realize certain prices for the milk.

The figures below show the cream and butter prices corresponding to the milk at a cent per pound, and three (3), four (4), and five (5) cents per (wine) quart.

These calculations contain no allowance for the differences in the labor involved in selling the various products of the dairy cow, as this element of cost varies greatly according to circumstances, and must be estimated for each individual case.

PRICES OF CREAM AND BUTTER CORRESPONDING TO MILK AT A CENT A POUND.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	cts.	cts.	cts.	cts.	cts.
Cream per quart	11.8	12.6	13.1	9.3	9.2
Butter per pound	28.6	30.2	37.1	18.1	17.3

PRICES OF CREAM AND BUTTER CORRESPONDING TO MILK AT THREE (3) CENTS PER QUART.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	cts.	cts.	cts.	cts.	cts.
Cream per quart	16.5	17.7	18.3	13.	12.9
Butter per pound	40.	42.3	51.9	25.3	24.2

Prices of Cream and Butter Corresponding to Milk at Four (4) Cents per Quart.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	cts.	cts.	cts.	cts.	cts.
Cream per quart	22.	23.6	24.4	17.3	17.3
Butter per pound	53.4	56.4	69.2	33.8	32.3

Prices of Cream and Butter Corresponding to Milk at Five (5) Cents per Quart.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	cts.	cts.	cts.	cts.	cts.
Cream per quart	27.5	29 5	30.5	21.7	21 6
Butter per pound	66.7	70.5	86.6	42.3	40.4

Composition of the Milk.

The milk of the several animals of the three breeds tested has been analyzed to as full an extent as time would permit.

The intention has been to analyze the milk of each cow on five successive days of each month, and this has been done with a few exceptions. During the time from June, 1888 to April, 1889, the night's milk and morning's milk have been analyzed separately, but since that time equal quantities of the two have been mixed and this mixture has been analyzed.

The percentage of ash, which is seen to be uniformly .75 per cent. has so far not been determined, but is assumed. An error of .10 per cent. or less is thereby caused, possibly, which falls on the sugar. It is probable that this percentage should be slightly less with the Holsteins and Ayrshires, judging from a few determinations that have been made.

The percentage of casein, albumen, etc., has been obtained by multiplying the percentage of nitrogen by 6.33. The percentage of sugar has been calculated by difference, but not until after this method was compared with actual gravimetric determinations.

The analysis shown in the tables below include the milk of from forty-five to sixty days. The averages for the periods of five days and for the whole year, are given :

TABLE SHOWING THE COMPOSITION OF MILK FROM HOLSTEIN, AYRSHIRE AND JERSEY COWS.

JANSJE.—(*Holstein.*)

	Solids.	Ash.	Casein, etc.	Sugar.	Fats.
	%	%	%	%	%
June 18-22	12.82	.75	3.43	5.12	3.52
July 23-27	11.44	.75	2.84	4.86	2.98
August 27-31	11.56	.75	3 03	4.67	3.11
September 24-28	11.65	.75	2.98	4.75	3.15
October 22-26	11.95	.75	3.10	4.74	3.46
November 19-23	12.29	.75	3.13	4.80	3.62
December 17-21	12.17	.75	3.04	4.81	3.57
January 21-25	12.43	.75	3.12	4.98	3.57
February 25-March 1	12.55	.75	3.29	5.04	3.46
April 1-6	12.58	.75	3.24	5.11	3.48
April 29-May 3	13.07	.75	3.65	5.24	3.43
June 3-7	13.23	.75	3.76	5.02	3.71
Average	12.31	.75	3.22	4.92	3.42

NANCY AVONDALE.—(*Ayrshire.*)

	Solids.	Ash.	Casein, etc.	Sugar.	Fats.
	%	%	%	%	%
June 18-22	12.64	.75	3.40	5.14	3.35
July 23-27	11.79	.75	3.39	4.47	3.18
August 27-31	11.93	.75	3 21	4.60	3.37
September 24-28	12.36	.75	3.26	4.96	3.39
October 22-26	13.04	.75	3.63	4.99	3.67
November 19-23	14.57	.75	4.24	5.31	4.27
December 17-21	14.78	.75	4.26	5.52	4.25
April 1-6	13.88	.75	3.25	4.95	4.92
April 29-May 3	12.34	.75	3.12	5.25	3 24
June 3-7	12 04	.75	3.09	5.16	3.05
Average	12.94	.75	3.48	5.03	3.67

QUEEN LINDA.—(*Ayrshire.*)

	Solids.	Ash.	Casein, etc.	Sugar.	Fats.
	%	%	%	%	%
October 22-26	13.62	.75	3.40	5.15	4.32
November 19-23	12.51	.75	3.01	5.26	3.49
December 17-21	12.43	.75	2.91	5.32	3.43
January 21-25	12.47	.75	2.89	5.37	3.47
February 25-March 1	12.62	.75	3.16	5.43	3.27
April 1-6	12.87	.75	3.21	5.41	3.49
April 29-May 3	12.64	.75	3.33	5.14	3.42
June 3-7	13.04	.75	3.47	5.38	3.44
July 15-19	14.27	.75	4.04	5.19	4.29
Average	12.94	.75	3.27	5.29	3.62

AGNES.—(*Jersey.*)

	Solids.	Ash.	Casein, etc.	Sugar.	Fats.
	%	%	%	%	%
September 24-28	13.72	.75	3.90	4.75	4.32
October 22-26	14.53	.75	4.01	4.60	5.17
November 19-23	14.62	.75	3.89	4.87	5.11
December 17-21	14.94	.75	4.05	4.97	5.19
January 21-25	14.95	.75	3.87	5.25	5.08
February 25-March 1	15.13	.75	4.19	5.16	5.08
April 1-6	15.42	.75	4.13	5.15	5.38
April 29-May 3	14.40	.75	4.34	5.20	5.19
June 3-7	14.98	.75	4.11	5.16	4.96
July 15-19	14.74	.75	4.11	4.69	5.18
Average	14.74	.75	4.06	4.98	5.06

IDA.—(*Jersey.*)

	Solids.	Ash.	Casein, etc.	Sugar.	Fats.
	%	%	%	%	%
September 24-28	14.06	.75	3.56	4.77	4.98
October 22-26	14.88	.75	3.75	4.51	5.88
November 19-23	15.19	.75	3.98	4.71	5.76
December 17-21	15.15	.75	3.97	4 86	5.57
January 21-25	15.39	.75	3.98	4.96	5.69
February 25-March 1	15.88	.75	4.23	5.06	5.84
April 1-6	16.02	.75	4.17	5.16	5.93
April 29-May 3	16.04	.75	4.32	4.93	6.03
June 3-7	16.95	.75	4.43	5.32	6.45
July 15-19	17.52	.75	5.06	5 83	5.88
Average	15.71	.75	4.14	5.01	5.80

Several facts are shown by these analyses which may not be new, but which are worthy of special mention.

(1.) The order of richness of the milk is Jersey, Ayrshire and Holstein, the Jersey leading the other two breeds by a large difference.

(2.) It is noticable that the milk of two cows for a time fell below what is considered in some states the legal standard, and would be condemned by an inspector as watered milk.

(3.) Analyses made of milk of three of the cows from one to two weeks after parturition showed it to be much richer than it was a month later, when it dropped to the point of least solids. In this decrease the Jerseys did not share. From the point of least solids there was a gradual increase in the percentage of solid matter up to the time of going dry, excepting with the Jersey "Agnes." This increase was not of fat alone, or casein alone, but took place with all the solids.

(4.) The lowest percentage of solids found for any cow was with the Holstein Jansje, 10.12 per cent. on July 25th, 1888, and the highest was with the Jersey Ida, 17.63, on July 16th, 1889. The percentage of fat in the two cases was 2.29 and 6.71 respectively.

Composition of the Skimmed Milk, Cream and Butter Milk.

The whole milk has been analyzed for five successive days of each month, or nearly so, as has been seen, and so have the skimmed milk, cream and butter milk coming from the milk during these periods.

The skimmed milk has been sampled and analyzed on each day of the five, but it has been necessary to sample only one lot of cream and butter milk. These samples are taken as follows: The skimmed milk is drawn off to within an inch of the cream, then stirred and a portion taken for analysis, after which the skimming is completed. In this way the accidental presence of fat from the cream is avoided. The cream is thoroughly stirred before churning and then sampled. The samples of butter milk are taken before it is mixed with the washings from the butter. The analysis have not been complete, only the total solids and fat having been determined. The results appear below:

Tables Showing the Composition of the Skimmed Milk, Cream and Butter Milk from the Several Cows.

Jansje.

	Skimmed Milk.		Cream.		Butter Milk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%
June 18-22	9.94	.54	26.00	19.26	9.35	.35
July 23-27	8.91	.24	21.72	14.60	8.83	.31
August 27-31	8.95	.36	22.82	15.72	8.98	.24
September 24-28	8.97	.18	22.73	15.46	8.78	.08
October 22-26	8.94	.21	24.00	16.76	9.94	1.26
November 19-23	9.15	.26	24.43	16.73	9.25	.21
December 17-21	9.05	.20	24.20	16.68	9.86	.65
January 21-25	9.33	.21	24.05	16.30	10.24	1.14
February 25-March 1	9.51	.26	23.73	15.95	9.81	.40
April 1-6	9.85	.41	22.73	14.63	10.05	.35
April 29-May 3	10.16	.22	24.02	15.77	10.28	.55
June 3-7	10.22	.44	24.59	15.74	10.80	.18
Average	9.41	.29	23.75	16.13	9.68	.48

NANCY AVONDALE.

	Skimmed Milk.		Cream.		Butter Milk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%
June 18-22	10.06	.73	24.59	17.26	10.14	.82
July 23-27	9.81	.50	24.77	17.46		
August 27-31	9.39	.56	24.30	17.25	9.30	.64
September 24-28	9.48	.34	23.96	16.68	9.82	.95
October 22-26	10.21	.61	23.80	15.82	9.69	.35
November 19-23	11.46	.86	25.27	16.16	10.89	.20
December 17-21	11.46	.68	24.90	15.92	11.52	.23
April 1-6	10.10	.66	25.95	17.90	9.41	.20
April 29-May 3	9.61	.34	24.45	16.68	9.77	.57
June 3-7	9.60	.30	25.02	16.78	9.96	.28
Average	10.12	.56	24.70	16 79	10.05	.47

QUEEN LINDA.

	Skimmed Milk.		Cream.		Butter Milk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%
October 22-26	10.77	1.03	26.21	18.50	9.59	.09
November 19-23	9.89	.72	23.46	15 60	9.64	.18
December 17-21	10.10	.76	23.55	15.80	10.44	1.05
January 21-25	10.08	.91	24.81	16.95	9.65	.25
February 25-March 1	10.62	.97	24.18	16.27	9.75	.08
April 1-6	10.67	1.04	25.97	16.65	9.85	.20
April 29-May 3	10.75	1.21	23.97	16.00		
June 3-7	11.07	1.39	27.01	18.84	10.36	.09
July 15-19	12.38	2.24	20.16	11.29	10.35	.83
Average	10.70	1.14	24.37	16.21	9.95	.34

AGNES.

	Skimmed Milk.		Cream.		Butter Milk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%
September 24-28	9.92	.13	26.15	18.43	9.56	.18
October 22-26	10.04	.14	26.84	19.19	9.68	.12
November 19-23	10.16	.25	26.94	18.77	10.14	.12
December 17-21	10.36	.21	27.55	19.63	10.23	.09
January 21-25	10.82	.15	27.08	18.72	10.52	.45
February 25-March 1	10.70	.16	26.90	18.63	10.23	.05
April 1-6	10.79	.24	26.77	18.28	10.82	.05
April 29-May 3	10.81	.23	28.67	20.37	10.70	.17
June 3-7	10.48	.45	29.68	20.38	11.14	.21
July 15-19	10.53	.48	27.60	19.60	10.70	.30
Average	10.46	.24	27.42	19.20	10.37	.17

IDA.

	Skimmed Milk.		Cream.		Butter Milk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%
September 24-28	9.77	.20	27.71	20.43	9.52	.12
October 22-26	9.70	.16	28.70	21.45	9.30	.06
November 19-23	10.12	.32	26.98	18.73	10.25	.13
December 17-21	10.17	.24	27.55	19.61	10.70	.22
January 21-25	10.57	.49	27.04	18.92	10.32	.31
February 25-March 1	10.81	.32	27.82	19.45	10.43	.07
April 1-6	11.09	.64	28.33	19.79	10.50	.15
April 29-May 3	11.66	1.11	28.78	20.17	11.03	.35
June 3-7	12.50	1.51	29.10	19.97	11.75	.20
July 15-19	13.19	1.65	24.80	15.39	11.18	.29
Average	10.96	.67	27.68	19.39	10.50	.19

The composition of these products can be more readily compared if the averages of the above tables are brought together.

Average Composition for One Year of the Skimmed Milk, Cream and Butter Milk.

	Skimmed Milk.		Cream.		Butter Milk.	
	Solids.	Fat.	Solids.	Fat.	Solids.	Fat.
	%	%	%	%	%	%
Jansje	9.41	.29	23.75	16.13	9.68	.48
Nancy Avondale	10.12	.56	24.70	16.79	10.05	.47
Queen Linda	10.70	1.14	24.37	16.21	9.95	.34
Agnes	10.46	.24	27.42	19 20	10.37	.17
Ida	10.96	.67	27.68	19.39	10.50	.19

There has prevailed somewhat generally the opinion that the skimmed milk of Jersey cows is of poorer quality than that of the Ayrshires or other breeds whose milk is not so rich in fat. That opinion is not sustained by these analysis, the Jersey skimmed milk proving to contain a higher per cent. of solids than that of the other two breeds. The same is true of the butter milk. Except for the first month or so, there is a gradual increase in the solids of the skimmed milk and butter milk up to parturition.

The average percentage of fat in the skimmed milk varies greatly, being least with one of the Jerseys, and largest with one of the Ayrshires. It is true, however, that during the time of a full flow of milk the percentage of fat in the skimmed milk of the Ayrshires were much larger than in the case of the other breeds, the Jerseys showing the instances of the most complete separation. It is true of all the cows without respect to breed, that the percentage of fat in the skimmed milk, or in other words the waste of fat, increases in a marked manner as the period of milking lengthens and parturition approaches.

The butter milk of the Jerseys shows least fat, the percentage being only about half that of the other cows.

Later will be given the percentage of the total fat of each cow which passes off in the waste products, when the relative loss will be more clearly seen.

The analyses of the cream coincide with the churn tests in showing the Jersey cream to be considerably richer in fat than that from the other breeds. Again while the cream grows richer in solids as the period of lactation lengthens and parturition approaches, (which is also true of the milk,) the percentage of fat does not increase but rather diminishes. The following figures show that this increase in solid matter falls upon other constituents of the cream than upon the fat, which is equivalent to showing that the fat in the milk of cows approaching parturition separates from the casein, etc., less readily and therefore less completely than in the early stages of the milking period :

Ratio of the Other Solids in Cream to the Fat.

	Jansje.		Nancy Avondale.		Queen Linda.		Agnes.		Ida.	
	Solids not fat.	Ratio of other solids to fat.	Solids not fat.	Ratio of other solids to fat.	Solids not fat.	Ratio of other solids to fat.	Solids not fat.	Ratio of other solids to fat.	Solids not fat.	Ratio of other solids to fat.
June 18th to June 22nd	6.74	1: 2.9	7.33	1: 2.4						
July 23d to July 28th	7.12	1: 2.0	7.31	1: 2.4						
August 27th to August 31st	7.10	1: 2.2	7.05	1: 2.4						
September 24th to September 28th	7.27	1: 2.1	7.28	1: 2.1			7.72	1: 2.4	7.28	1: 2.8
October 22nd to October 26th	7.24	1: 2.3	7.98	1: 2.0	7.71	1: 2.4	7.65	1: 2.5	7.25	1: 3.0
November 19th to November 23d	7.70	1: 2.2	9.11	1: 1.8	7.86	1: 2.0	8.17	1: 2.3	8.25	1: 2.3
December 17th to December 21st	7.52	1: 2.2	8.98	1: 1.8	7.75	1: 2.0	7.92	1: 2.5	7.94	1: 2.5
January 21st to January 25th	7.75	1: 2.1			7.86	1: 2.1	8.36	1: 2.2	8.12	1: 2.3
February 25th to March 1st	7.78	1: 2.0			7.91	1: 2.1	8.27	1: 2.2	8.37	1: 2.3
April 1st to April 6th	8.10	1: 1.8	8.05	1: 2.2	9.32	1: 1.8	8.49	1: 2.1	8.54	1: 2.3
April 29th to May 3d	8.25	1: 1.9	7.77	1: 2.1	7.97	1: 2.0	8.30	1: 2.4	8.61	1: 2.3
June 3d to June 7th	8.75	1: 1.8	8.24	1: 2.0	8.07	1: 2.2	9.30	1: 2.2	9.21	1: 2.1
July 15th to July 19th					8.87	1: 1.[illegible]	8.00	1: 2.4	9.41	1: 1.6

It is a matter of some importance to know just what is the distribution of the solids of the milk in the various products into which it is separated, viz: The skimmed milk, butter milk and butter. In other words, what proportion of the food value of the milk does a farmer retain in the skimmed milk, or butter milk, or both?

Knowing the quantities of whole milk, skimmed milk and butter milk, and also their monthly composition, we are in a position to calculate to a close approximation the total solids of each for the year, as has already been done for the whole milk.

The attention of those who are debating the question of selling milk or making butter is invited to the figures here presented as furnishing a definite basis for the consideration of the matter:

TABLE SHOWING THE QUANTITIES OF DAIRY PRODUCTS FROM EACH COW.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	lbs.	lbs.	lbs.	lbs.	lbs.
Whole Milk	9991	5948	6983	6876	4107
Cream (Sour)	1770	971	947	1546	910
Skimmed Milk	8172	4940	5974	5290	3156
Butter Milk	1278	688	681	1000	567
Butter	349	197	188	379	238

TABLE SHOWING THE SOLID MATTER IN THE DAIRY PRODUCTS FROM EACH COW.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
Whole milk solids, pounds	1227.7	751.1	893.6	1015.2	638.4
Cream solids, pounds	415.2	238.8	230	415.7	253.18
" " % of total milk solids	33.8	31.8	25.7	40.9	39.7
Skimmed milk solids, pounds	768.5	491.9	632.1	557.2	340.9
" " " % of total milk solids	62.6	65.5	70.6	54.9	53.4
Butter milk solids, pounds	124.2	68.01	64.1	104.07	59.04
" " " % of total milk solids	10.1	9.0	7.2	10.2	9.2

It appears that the solids of the skimmed milk and butter milk range with these five cows from 63 per cent. to 77 per cent. of the total milk solids, and that the total quantity of solids in the skimmed milk is from five to ten times as large as those of the butter milk.

The Waste of Fat in the Skimmed Milk and Butter Milk.

A cow's butter producing capacity does not wholly depend upon the quantity and quality of her milk, but in part also upon the amount of fat that is retained by the skimmed milk and butter milk. It is possible that the centrifugal machine or butter extractor will reduce all milk, without regard to breed or individual, to the same level in the matter of waste, but with the present cold-setting method, even when it is well managed, there is an unquestioned difference in the way in which the milk of different cows behaves.

The cows involved in this test furnish a striking illustration not only of the great variation with different animals of the fat in the waste products from butter-making, but also of the large loss that may occur in ordinary practice and not be observed. It is very evident that the individuality of the animal has much more to do with the amount of fat left in the skimmed milk than has food or season.

The figures below are suggestive, and in part furnish an argument for the use of the separator:

Table Showing the Waste of Fat in the Skimmed Milk and Butter Milk for One Year.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
	lbs.	lbs.	lbs.	lbs.	lbs.
Total fat in milk	340.4	208.8	245.9	352.	237.8
Fat left in skimmed milk	22.9	24.8	64.	13.1	19.3
Fat left in butter milk	6.1	3.3	2.1	1.4	1.0
Total fat in waste products	29.	28.1	66.1	14.5	20.3
	%	%	%	%	%
Per cent. waste in skimmed milk	6.7	11.9	26.0	3.7	8.1
" " " butter milk	1.8	1.6	0.8	0.4	0.4
" total waste	8.5	12.5	26.8	4.1	8.5

The yearly loss with individual cows varied from 14.5 pounds to 66.1 pounds of fat, or from one pound in twenty-five to one pound in four of the total butter fat. At least ninety per cent. of this loss was in the skimmed milk. Granting that a Separator would take out the fat from the milk of all the cows equally clean, so that in no case would the residue exceed .10 per cent., then the loss in the skimmed milk would vary with these cows from three to eight pounds yearly.

The yearly saving for a herd of cows like the Jersey Agnes would then not exceed $1.50 per cow, while for such cows as Nancy Avondale and Queen Linda the saving would be not far from $5.50 and $16.50 respectively, reckoning butter at twenty-two cents per pound. It is possible that the milk of such cows as Queen Linda can be manipulated in some other way by the addition of water or otherwise, so as to overcome to some extent the cause which prevents the easy rise of the fat globules.

The Effect of Food Upon the Availability of the Fat of Milk.

The term "churnability," or the availability for conversion into butter of the fat of milk, is one of no significance, some claim. That may be true if the milk is to be manipulated with the aid of the Separator or Butter Extractor, but not if the cream is to be raised by the method now most commonly in use in Maine. We have seen how largely different the percentage of waste of fat is with different cows. What as to the waste with the same cow when fed rations greatly unlike? It now seems to be accepted by some, prematurely it appears to others, that ensilage as a food increases the proportion of the total fat of the milk which finds its way into the butter. The observations made at this Station during the past year do not accord with that view. Let us examine the data bearing upon this point.

During the season of 1888-89, the cows were fed dry food exclusively until March 8th. From that date to May 10th they were given from forty to fifty pounds of ensilage per day, when they were returned to dry feed until they were sent to the pasture early in June.

As analyses of the skimmed milk and butter milk were made for five consecutive days in each month, it is possible to ascertain whether these products contained less fat while the ensilage was being eaten than before or after. Below can be seen the percentage of fat in the waste products from Jan. to July, inclusive:

	Jansje.		Queen Linda.		Agnes.		Ida.	
	Fat in Skimmed Milk.	Fat in Butter Milk.	Fat in Skimmed Milk.	Fat in Butter Milk.	Fat in Skimmed Milk.	Fat in Butter Milk.	Fat in Skimmed Milk.	Fat in Butter Milk.
	%	%	%	%	%	%	%	%
DRY FOOD.								
January 21st to January 25th......	.21	1.14	.91	.25	.15	.45	.49	.31
February 25th to March 1st........	.26	.40	.97	.08	.16	.05	.32	.07
Average............................	.23	.77	.94	.16	.15	.25	.40	.19
ENSILAGE.								
April 1st to April 6th...............	.41	.35	1.04	.20	.24	.05	.64	.15
April 29th to May 3d................	.22	.55	1.21		.23	.17	1.10	.35
Average............................	.31	.45	1.12	.20	.23	.11	.87	.25
DRY FOOD.								
June 3d to June 7th................	.44	.18	1.39	.09	.45	.21	1.51	.20
GRASS.								
July 15th to July 19th..............			2.24	.83	.48	.30	1.65	.29

It does not appear from the above results that the ensilage or grass exerted any influence upon the amount of fat left in either the skimmed milk or butter milk. There is a gradual increase of fat in the skimmed milk due to the advancing period of lactation, while the butter milk follows no general law. Certainly if the change in food produced any effect upon the "churnability" of the milk it was so small as to be obscured by other influences.

THE RELATION OF THE TOTAL FAT IN THE MILK TO THE BUTTER OBTAINED.

There seems to be a desire among those taking a leading interest in dairy matters to fix some butter standard that shall constitute a basis for testing single cows or herds. It is suggested that a *standard butter*, i. e. a butter of a certain composition, shall be adopted, and that a cow's yield shall be so many pounds of such butter. It is further suggested that the amount of this standard butter can be computed from the amount of fat contained in the milk of the cow tested, without the trouble of a churning test. Such

a prompt and labor saving method is certainly desirable. The objection raised to it is that a much smaller percentage of the total fat of the milk finds its way into the butter with some cows than with others, and that if it is characteristic of an individual or a breed to leave a large residue of fat in the waste products this fact should have its influence upon the outcome of the test. It is urged on the other hand that by the most approved methods of handling milk the fat residues in the skimmed milk and butter milk can be made practically the same for all animals without regard to individuality or breed, and that a cow should be judged by what she will do when her milk is manipulated in the best possible manner. If it is true that we can now overcome the characteristic differences of milk from different animals, or are likely to do so, so that the fat becomes equally available in all cases, then it would certainly be wise to base a cow's butter capacity upon the fat in her milk. The data collected in testing the Station cows bear upon this question to some extent.

There is known the total fat in the milk, the fat in the waste products, the fat in the cream, and the weight of butter produced.

TABLE SHOWING THE RELATION OF THE QUANTITIES OF FAT IN THE MILK, CREAM AND BUTTER.

	Jansje.	Nancy Avondale.	Queen Linda.	Agnes.	Ida.
Weight of butter, pounds.	349.5	197.	188.	379.5	238.
Total fat of milk, "	340.4	208.8	245.9	352.	237.8
Fat in waste products, pounds.....	29.	28.1	66.1	14.5	20.3
Fat left for butter, "	311.4	180.7	179.8	337.5	217.5
Fat found in sour cream, pounds........................	285.	163.5	154.	292.9	178.5
Fat in butter milk, pounds................................	6.1	3.3	2.1	1.4	1.0
Fat left for butter, "	278.9	160.2	151.9	291.5	177.8
Ratio of whole fat minus fat of waste products, to the weight of butter.* Butter=100.	89	92	96	89	91
Ratio of fat of sour cream minus fat of butter milk, to weight of butter. Butter=100	80	81	81	77	75

* Worked, unsalted butter.

In studying these figures we discover that these two sets of results are inconsistent.

The fat in the whole milk diminished by the amount in the skimmed milk and butter milk should be the same as that of the cream less the fat in the butter milk. This does not seem to be the case, however, neither does there appear to be any error in the data. We are not now able to explain this discrepancy. The possible causes are an actual loss of fat, errors of weighing, and errors of chemical analysis. It is already ascertained that the second named cause could not have existed, certainly not to produce an error so large, so uniform and always on the same side. By using the figures of a previous table we learn that the solids of the sour cream added to the solids of the skimmed milk, also fall short of equaling the solids of the whole milk. The difference can be seen below:

	Jansje.	Nancy Avondale	Queen Linda.	Agnes.	Ila.
	lbs.	lbs.	lbs.	lbs.	lbs.
Solids in whole milk	1227.7	751.1	893.6	1015.2	638.4
Solids in sour cream and skimmed milk	1183.7	730.7	862.1	972.9	594 1
Difference	44.	20.4	31.5	42.3	44.3
Discrepancy in fats	32.5	20.5	27.9	46.	39.7

There is a similarity in these two sets of figures that is significant. It is very evident that this apparent loss of solids falls almost entirely upon the fat. Is it an *actual* loss of fat? An investigation having as an object a definite answer to this question is already planned. It is possible that it will receive a negative reply, but it is difficult to understand what can be the nature of the error, if one has occurred. Whatever it may be, whether of analytical work or not, it is worth while to find it.

It is a fact that the amount of fat found in the sour cream stands in about the right relation to the weight of butter, i. e., as 79 to 100. Fresh, unsalted butter will average less rather than over eighty per cent of fat. This makes it appear that the weight of fat in the whole milk diminished by the amount of fat in the skimmed milk and butter milk is too large for the butter produced, the ratio being 91 to 100. This fact goes to show that the descrepancy is not due to errors in the laboratory.

The Length of Time Required for Churning the Cream from the Different Cows.

A careful record has been kept of the length of time required for churning each mess of cream from each cow, and the average for the year is as follows:

	TIME OF CHURNING.	TEMPERATURE OF CREAM.
Jansje,	44 minutes,	64° F.
Nancy Avondale,	33 "	63° "
Queen Linda,	37 "	64° "
Agnes,	41 "	64° "
Ida,	38 "	64° "

Summary.

(1.) The amount and cost of production from the three breeds can more safely be discussed at the end of another year's work.

(2.) The results of this test show that milk or butter production may be profitable or unprofitable according to the kind of animal used. The food expense of a pound of milk solids, a quart of cream or a pound of butter fat is from fifty-five to sixty-nine per cent. larger, as the case may be, with the cows producing the smallest quantities.

(3.) A pound of dry matter has been produced from these five cows at an average food-cost of 7.2 cents, which is not far from half the food-cost of the dry matter in a fat steers carcass, only about fifty per cent. of which is edible.

(4.) The cream from different cows was unlike in butter value, that from the cows giving the poorest milk yielding less butter by about twenty-five per cent. than the Jersey cream.

(5.) Cream from the cows when in an advanced state of pregnancy had a diminished butter value.

(6.) The Holstein milk averaged the poorest and the Jerseys the richest in total solids and fat.

(7). The milk of all the cows but one gradually increased in its percentage of solid matter as the period of lactation lenghtened. and the time of parturition approached.

(8.) The Jersey skimmed milk proved to contain a slightly larger percentage of solids than the Ayrshire skimmed milk, the Holstein skimmed milk being much poorer than that of the other two breeds, the order being 10.7%, 10.4%, and 9.4%.

(9.) The skimmed milk of the Ayrshires contained a large percentage of fat throughout the entire milking period, the separation of fat seeming to be less perfect than with the other two breeds.

(10.) The butter milk of each cow contained about the same percentage of total solids as her skimmed milk, the quality following the same order as to breeds, viz: 10.44%, 10.00%, and 9.68%.

(11.) The butter milk of the Jerseys contained less than half as much fat as that of the other two breeds.

(12.) A careful test with five cows furnishes no evidence that a change of food from hay to ensilage or to grass diminished the waste of fat in the skimmed milk and butter milk.

(13.) From 53% to 70% the solids of the milk were found in the skimmed milk, and from 7% to 10% in the butter milk.

(14.) The percentage waste of fat in the skimmed milk and butter milk varied from 4.1% to 26.8%, of the total fat, being least for the Jerseys and greatest for the Aryshires. Over 90% of this waste was in the skimmed milk.

(15.) The fat in the sour cream was 79% of the weight of worked unsalted butter.

EXPERIMENTS WITH FERTILIZERS.

PROF. WALTER BALENTINE.

In accordance with the recommendations of the Station Council, the experiments on the availability of phosphoric acid in finely ground phosphatic rocks have been continued by using South Carolina rock and Caribbean Sea guano, in field and pot experiments.

The South Carolina rock was selected for the work on account of its being a crude material which is a standard article in the fertilizer trade. The Caribbean Sea guano was a phosphate of iron and alumina, and was used in the experiments because it seemed to be desirable to obtain further information in regard to the action of this class of phosphates on crops.

The crude phosphates used in both field and pot experiments were finely ground, the South Carolina rock carrying 27.2 per cent. phosphoric acid and the Caribbean Sea guano 37.5 per cent. The soluble phosphoric acid was furnished by acid South Carolina rock having 13.3 per cent. available and 3.1 per cent. insoluble phosphoric acid.

Field Experiments by Farmers.

For the field experiments sets of fertilizers were prepared in duplicate to be applied to plots of one-tenth of an acre. Two plots were to receive acid South Carolina rock at the rate of 500 pounds per acre, with ammonium sulphate at the rate of 150 pounds and muriate of potash at the rate of 100 pounds per acre. The two plots thus manured would receive a liberal supply of available plant food.

Two plots were to receive finely ground South Carolina rock at the rate of 1000 pounds per acre, with sulphate of ammonia at the rate of 150 pounds and muriate of potash at the rate of 100 pounds per acre. This would give to these two plots the same amount of potash and nitrogen as the plots to which the acid South Carolina rock was applied and four times as much phosphoric acid, but the phosphoric acid would be in an insoluble form. The cost of the phosphoric would be about the same in each case.

Two plots were to receive ground Caribbean Sea guano at the rate of 725 pounds per acre with the same amount of sulphate of ammonia and muriate of potash as in the preceding cases. This also provides for four times the amount of phosphoric acid in an insoluble form as would be applied of soluble phosphoric acid where the acid South Carolina rock was used, at about the same cost per plot.

Two plots were to be cultivated with an application of 150 pounds of sulphate of ammonia and 100 pounds of muriate of potash, to show to what extent the phosphates increased the crop in each case over what would have been produced if they had not been applied.

In addition two plots were to be cultivated without manure, to determine the capacity of the soil to produce crops at the time of the experiment.

Sets of fertilizers like those described above were sent out to four farmers in different parts of the State, with directions for their application. Three of these farmers have furnished reports of their work which are of considerable interest. In each case one-half of the fertilizers were applied broad cast and the remainder in the hill.

Following are given the reports of the farmers having charge of the work.

Mr. H. L. Leland's Experiment at East Sangerville.

DESCRIPTION OF SOIL.

Hill land; a dry slaty loam; a good potato soil; land in grass previous season, cut one-half ton of hay per acre, plowed in Fall of 1888. Planted to Beauty of Hebron potatoes, using for seed ten bushels per acre. Fertilizers applied at the time of planting. The crop was well hoed and kept free from weeds.

The following table gives the numbers of the plots, fertilizers used, rate of application and yield per acre:

No. of Plot.	Name of fertilizer.	Amount per acre.		Yield per acre of potatoes.*
1.	Acid S. C. Rock. Sulphate of ammonia. Muriate of potash.	500 150 100	pounds. " "	68⅓ bushels
2.	Fine ground S. C. Rock. Sulphate of ammonia. Muriate of potash.	1000 150 100	" " "	50 "
3.	Caribbean Sea Guano. Sulphate of ammonia. Muriate of potash.	725 150 100	" " "	40 "
4.	Sulphate of ammonia. Muriate of potash.	150 100	" "	22 "
5.	No fertilizer.			30 "
1a.	Acid S. C. Rock. Sulphate of ammonia. Muriate of potash.	500 150 100	" " "	65 "
2a.	Caribbean Sea Guano. Sulphate of ammonia. Muriate of potash.	1000 150 100	" " "	48⅓ "
3a.	Caribbean Sea Guano. Sulphate of ammonia. Muriate of potash.	725 150 100	" " "	33⅓ "
4a.	Sulphate of ammonia. Muriate of potash.	150 100	" "	21⅓ "
5a.	No fertilizer.			29⅓ "

* Rust killed potato vines about August 15th, or the yield would probably have been greater.

Mr. William Downes' Experiment at Sebec.

DESCRIPTION OF SOIL.

Corn was planted on old sod land that had received no manure for six years. The ground was plowed May 22nd six inches deep; corn planted May 25th. The result is shown in the following table:

No. of Plot.	Name of fertilizer.	Amount per acre.	Yield per acre of		
			Corn on Cob.	Equivalent of Shelled Corn.*	Corn Fodder.
		lbs.	lbs.	bush.	lbs.
1.	Acid S. C. Rock. Sulphate of ammonia. Muriate of potash.	500 150 100	4660	66.6	4610
2.	Fine ground S. C. Rock. Sulphate of ammonia. Muriate of potash.	1000 150 100	2630	37.6	2730
3.	Caribbean Sea Guano. Sulphate of ammonia. Muriate of potash.	725 150 100	2660	38.0	2370
4.	Sulphate of ammonia. Muriate of potash.	150 100	1260	18.0	2120
5.	No fertilizer.		1130	16.1	1450
1a.	Acid S. C. Rock. Sulphate of ammonia. Muriate of potash.	500 150 100	3720	53.1	4640
2a.	Fine ground S. C. Rock. Sulphate of ammonia. Muriate of potash.	1000 150 100	2320	33.1	3410
3a.	Caribbean Sea Guano. Sulphate of ammonia. Muriate of potash.	725 150 100	2410	34.4	3340
4a.	Sulphate of ammonia. Muriate of potash.	150 100	1220	17.1	1570
5a.	No fertilizer.		1570	22.4	1910

* Calculated into bushels of shelled corn by dividing the weight of corn on cob by 70.

Mr. G. A. Glover's Experiment at Naples.

DESCRIPTION OF SOIL.

The land selected for this experiment produced about a ton and a half of hay to the acre nine years ago; has been in pasture since, the cattle being housed at night. Soil heavy loam with hard pan subsoil.

No. of Plot.	Name of fertilizer.	Amount per acre. lbs.	Yield per acre of Shelled Corn. bush.	Yield per acre of Corn Fodder. lbs.
1.	Acid S. C. Rock. Sulphate of ammonia. Muriate of potash.	500 150 100	58.7	7500
2.	Fine ground S. C. Rock. Sulphate of ammonia. Muriate of potash.	1000 150 100	46.7	5327
3.	Caribbean Sea Guano. Sulphate of ammonia. Muriate of potash.	725 150 100	34.7	4200
4.	Sulphate of ammonia. Muriate of potash.	150 100	29.4	3620
5.	No fertilizers.		3.3	1500
1a.	Acid S. C. Rock. Sulphate of ammonia. Muriate of potash.	500 150 100	61.9	8160
2a.	Fine ground S. C. Rock. Sulphate of ammonia. Muriate of potash.	1000 150 100	44.5	5160
3a.	Caribbean Sea Guano. Sulphate of ammonia. Muriate of potash.	725 150 100	38.7	4730
4a.	Sulphate of ammonia. Muriate of potash.	150 100	28.8	3520
5a.	No fertilizer.		3.2	1437

In these experiments it will be fair to attribute the gain in crops on the plots to which the phosphates were applied, over those on which sulphate of ammonia and muriate of potash alone were used, to the phosphoric acid taken up by the crop from the phosphatic fertilizing material.

In Mr. Leland's experiment, the highest yield per acre of the plots to which sulphate of ammonia and muriate of potash alone were supplied, was 22 bushels. Taking this as the measure of what the soil was able to produce under the conditions of the experiment when only sulphate of ammonia and muriate of potash were applied, we have on the plots on which fine ground South Carolina rock was used in addition to sulphate of ammonia and

muriate of potash a gain of 26 1-3 bushels in one case and 28 bushels in another. The Caribbean Sea guano gave a gain of 11 1-3 bushels in one case and 18 bushels in another.

In Mr. Downes' experiment if we take the highest yield of the sulphate of ammonia and muriate of potash plots as the measure of capacity of the soil when manured with those materials alone, under the conditions of the experiment, then we have on plot 2, 20.2 bushels corn due to the application of finely ground South Carolina rock and on plot 2a, 15 bushels; and in plot 3, 20.9 bushels and 3a, 17.3 bushels to be attributed to Caribbean Sea guano.

In Mr. Glover's experiment the indications of the availability of the insoluble phosphoric acid of South Carolina rock and the Caribbean Sea guano are less marked; but even here the least amount of corn to be attributed to the action of the crude phosphates is 5.3 bushels, while the largest amount reaches 17.3 bushels. Plots 1 and 1a to which the acid South Carolina rock was applied gave a much larger yield in every case than those plots to which the crude phosphates were applied, though the total amount of phosphoric acid was only one-fourth as much.

The conclusions to be drawn from the above data are: (1) That the insoluble phosphoric acid in the finely ground South Carolina rock and the finely ground Caribbean Sea guano was able to furnish a considerable amount of phosphoric acid to the crops; (2) That the first crops were not able to avail themselves of as much phosphoric acid from the 272 pounds furnished by the 1000 pounds of finely ground South Carolina rock and the 725 pounds of Caribbean Sea guano as from the 65 pounds soluble phosphoric acid furnished by the 500 pounds of acid South Carolina rock. There is left, however, for the use of future crops a much larger amount of phosphoric acid from the finely ground rock phosphates than from the acid rock.

Attention may be called to the different action of the potash and nitrogen when applied without phosphates. In the experiments of Messrs. Leland and Downes they had practically no effect on the crops, while in Mr. Glover's experiment when applied alone they increased the crop in one case 26.1 bushels and in another 25.6 bushels.

Pot Experiments.

The pots in which our pot experiments were conducted were like those devised and used by Wagner. They were constructed

as follows: A cylinder of galvanized iron ten inches in diameter and twenty inches high with a row of perforations about an eighth of an inch from the bottom is soldered into the center of a pan fourteen inches in diameter and three inches high. At the top of the pan a collar is soldered to the cylinder and to the pan, which has a perforation for the introduction of water into the pan. Through the bottom of the pan outside of the cylinder pass two tubes, one being flush with the bottom of the pan on the inside and the other extending up into the pan just two inches. Both extend about two inches below the bottom of the pan.

The first tube is for washing out the pots and is corked when the pots are in use. The second is the overflow tube which regulates the height of the water in the reservoir. A little below the top of the cylinder handles are soldered to opposite sides for convenience in handling the pots. The inside of the pots were painted with asphaltum paint to prevent rusting, and the outside with white lead to prevent undue absorption of heat.

Pots of the above description were filled to the depth of one inch with coarse gravel and then to the top with crushed quartz sand. It required for this purpose 65 pounds of sand for each pot, with the last 35 pounds of which was mixed the fertilizers used in the experiment.

These pots were set in double rows on a bench running nearly North and South. Water was then introduced into the reservoirs until it rose to the top of the overflow tube under which there had previously been placed glass jars. The water passing through the perforations in the cylinders rose to the height of two inches on the inside, so that it stood in all of the pots eighteen inches from the top. Rain water from a slate roof was supplied to the pots daily to make good the loss by evaporation, except that after rains when the water falling on the pots caused an overflow of the reservoir into the glass jars below, the overflow water was used for watering the pots.

In each of these pots were planted twenty oats of the same variety. After they had grown to the height of about three inches the plants were thinned out to eighteen to the pot on account of one or two plants having died in some of the pots. The oats rusted badly which doubtless depressed the yield in all of the pots, and to this may in part be attributed the variation in yield of pots receiving like treatment as to fertilizers.

The phosphates used in the pot experiments were of the same kind and composition as those used in the field experiments.

The tables below show the kinds and amounts of fertilizers supplied to each pot and the amount of grain and straw product:

Kind and quantity of fertilizers.	No. of Pot.	Weight of grain in grams.	Weight of straw in grams.
3 grams muriate of potash,	16	22.88	67
10 " nitrate of soda,	20	18.85	72
10 " acid S. C. rock.	24	24.37	65
3 grams muriate of potash,	2	3.19	12
10 " nitrate of soda,	6	1.72	5
5.5 " S. C. rock.	10	2.74	10
3 grams muriate of potash,	3	5 60	15
10 " nitrate of soda,	7	6.75	17
4 " Caribbean Sea guano.	11	6.98	15

The average yield of oats in pots 16, 20 and 24 was at the rate of 128 bushels per acre, showing that these pots received plant food of all kinds in quantities sufficient to produce a good crop.

Pots 2, 6 and 10 received the same amounts of potash and nitrogen and twice as much insoluble phosphoric acid as 16, 20 and 24 had of soluble phosphoric acid. The average yield of grain however was only at the rate of about 15 bushels per acre.

Pots 3, 7 and 11 were treated the same as 2, 6 and 10 with the exception that the same quantity of phosphoric acid was furnished in Caribbean Sea guano instead of South Carolina rock. The average yield of grain was at the rate of 37.8 bushels per acre. The depression of the yield caused by the substitution of the crude phosphates for acid South Carolina rock may have been in part due to the fact that the acid phosphate contained a considerable portion of sulphate of lime which the crude rock could have carried only to a slight degree. The principal cause of the depression, however, is believed to be due to the inability of the plants to obtain a sufficient amount of phosphoric acid to produce a maximum crop from the materials presented. Let the cause of the depression be what it may the experiment leaves little room to doubt that a considerable amount of phosphoric acid was obtained

by the plants from the crude phosphatic rock, amounting in the case of the Caribbean Sea guano to enough to produce more than an average crop of grain.

Experiments with Feldspar as a Source of Potash.

In connection with the experiments with finely ground phosphatic rock as a source of phosphoric acid for plants, pot experiments have been undertaken to determine to what extent plants can avail themselves of the potash of potash feldspar. The pots used for the experiments were like those described above and used in the phosphate experiments. They were also filled in the same manner, having first a layer of gravel at the bottom and above this 65 pounds of quartz sand, with the last 35 pounds of which were mixed the experimental fertilizers.

Three pots 1, 5 and 9 were supplied each with 10 grammes of feldspar carrying 11.61 per cent. of potash, 10 grammes of nitrate of soda and 10 grammes of acid South Carolina rock. Three other pots 13, 17 and 20 were fertilized with 20 grammes of feldspar and the same amount of nitrate of soda and acid phosphate as was supplied to 1, 5 and 9. In these pots were planted oats. When the oats were two or three inches high they were thinned out to 18 plants per pot. The pots were watered in the same manner as were those in which the experiment with phosphates were conducted.

In the tables below are shown the results of substituting muriate of potash for feldspar as a source of potash.

Kind and quantity of fertilizers.	No. of Pot.	Yield of grain in grams	Yield of straw in grams.
10 grams feldspar, 10 " nitrate of soda, 10 " acid S. C. rock.	1	18.37	47
	5	14.37	43
	9	19.43	47
20 grams feldspar, 10 " nitrate of soda, 10 " acid S. C. rock.	13	17.28	47
	17	16.78	47
	21	16.83	52
3 grams muriate of potash, 10 " nitrate of soda, 10 " acid S. C. rock.	16	22.88	67
	20	18.85	72
	24	24.37	65

The pots receiving ten grammes of feldspar produced on the average about 79 per cent. of the average of the grain produced by those pots receiving three grammes of muriate of potash having 50 per cent. of actual potash. The amount of grain was not increased by increasing the feldspar to 20 grammes though there was a slight gain in straw.

The conclusion to be drawn from the experiment is that the oats were able to draw from the feldspar potash enough for a large crop of grain. If this conclusion is verified by future work, some of our feldspars may prove a cheap souice of potash to the farmers of the State.

EXPERIMENTS IN GROWING MIXED GRAINS.

PROF. WALTER BALENTINE.

Experiments in determining the relative amount of stock food that can be produced by sowing mixed peas and oats as compared with oats grown alone, and mixed peas and barley as compared with oats and peas or oats, were not entirely satisfactory on account of the rust attacking the oats and thereby depressing the yield.

Three plots, 244 feet by 150 feet containing 85-100 of an acre, were selected and fertilized at the rate of 1000 pounds of finely ground South Carolina rock, 150 pounds of sulphate of ammonia and 100 pounds of muriate of potash per acre. One plot was sown to oats and peas at the rate of two bushels of oats and one bushel of Canada peas per acre, one plot to oats at the rate of two bushels to the acre and one plot to barley and peas at the rate of one and one-half bushels of barley and one bushel of peas per acre.

NAME OF CROP.	TOTAL CROP.	GRAIN.
Oats and Peas,	2330 lbs.	700 lbs.
Oats,	2565 "	689 "
Barley and Peas,	3200 "	978 "

The plot on which the barley and peas were sown produced but little barley, the barley plants apparently having been smothered by the peas.

One of the principal objects in sowing peas and grain together is that the peas shall be held in an upright position by the grain; this office the barley did not fulfill in our experiment and on account of the weakness of the straw of the barley it is doubtful if it is desirable to use as a crop to grow with peas.

TESTS OF VARIETIES.

PROF. WALTER BALENTINE.

FIELD TESTS WITH VARIETIES OF BARLEY AND OATS.

For several years the Station has been doing considerable work in testing varieties of oats and barley. Of the many varieties of oats and barley on trial during these years only a few have been considered of sufficient merit to warrant us in continuing to grow them. Of these there were two of barley and five of oats, which were sown on half acre plots with the following results as to yield in grain:

NO. OF PLOT.	NAME OF VARIETY.	YIELD OF GRAIN.
1	Chevalier Barley,	813 lbs.
2	Champion two rowed Barley,	1112 "
3	White Seizure Oats,	472 "
4	Victoria Oats,	578 "
5	New Race Horse Oats,	634 "
6	Clydesdale Oats,	450 "
7	Henderson's Clydesdale,	190 "

The yields of barley were very satisfactory but owing to the attack of rust on the oats the results are not as favorable for any of the varieties as was expected from the condition of the ground on which they were sown and the previous yields of these varieties on similar plots.

TEST OF VARIETIES OF PEAS.

Six varieties of peas which have not been tested previously at the Station have been on trial with the following results:

Number.	Name.	When planted.	Date of blossoming.	When peas were large enough to shell.	Date of pulling.	Weight.	Quality.
1	American Champion	May 30	July 12	July 31	Aug. 28	12 lbs., 8 oz.	Good.
2	Yorkshire Gem	" 30	" 15	Aug. 3	" 28	18 " 6 "	Extra.
3	Sander's Marrow	" 30	" 17	" 15	Sept. 10	15 "	Good.
4	Epicure	" 30	" 2	July 20	Aug. 19	4 " 2 "	Inferior.
5	Melting Sugar	" 30	" 10	Aug. 1	" 28	5 " 9 "	Inferior.
6	Henderson's Wild Summer	" 30	" 13	" 3	" 28	6 " 13 "	Extra.

Potato Tests.

One hundred and seven varieties of potatoes have been on trial with the results shown in the following table:

Number.	Name of Potatoes.	Date of planting.	Number of hills.	Date of blossoming.	Date of tops dying.	Date of digging.	Weight of large.	Weight of small.	Quality.
							lbs.	lbs.	
1	Advance	May 15	120	July 4	Aug. 12	Sept. 19	35	12	Good.
2	Alexander's Prolific	"	120	June 25	" 14	" 19	169½	11	"
3	Beauty of Hebron	"	120	" 27	" 12	" 19	39	10½	"
4	Belle	"	20	July 2	" 14	" 19	78	4½	"
5	Burbank Sport	"	20	" 8	" 15	" 19	84	12½	"
6	Burbank Seedling	"	120	June 27	" 15	" 19	114	12	"
7	Bonanza	"	120	July 8	" 20	" 20	45½	13	Inferior.
8	Brownell's Best	"	70	" 17	" 17	" 2	51	14	Good.
9	Bliss' Triumph	"	10		" 12	" 20	99	9	"
10	Beauty of Beauties	"	104	" 1	" 15	" 20	65	7½	"
11	Clark's No. 1	"	120	June 25	" 12	" 20	53½	12	"
12	Charter Oak	"	120	July 12	" 17	" 20	108	5½	Medium.
13	Charles Downing	"	120	" 2	" 17	" 20	119	35	Good.
14	Cowhorn	"	88	" 7	" 19	" 2	89	7	Medium.
15	Dunmore	"	120	" 11	" 19	" 20	75	13	Good.
16	Dictator	"	120		" 20	" 20	101½	14	Inferior.
17	Delaware	"	120	June 22	" 2[illegible]	" 23	114½	19	Good.
18	Dakota Red	"	120	July 8	" 17	" 23	82	21	Medium.
19	Early Ohio	"	120	June 29	" 17	" 23	80	16	"
20	Early Maine	"	120	" 27	" 12	" 23	72	21	Inferior.
21	Early Vermont	"	120	July 4	" 12	" 23	55	20	Medium.
22	Early Sunrise	"	120	" 3	" 12	" 23	67	14	Good.
23	Early Essex	"	120	" 2	" 12	" 23	45	10	"
24	Early Goodrich	"	120	" 8	" 12	" 23	123½	16	Medium.
25	Early Gem	"	100	June 27	" 12	" 23	49	14	"
26	Early King	"	81		" 12	" 23	63	12	"
27	Early Mayflower	"	9[illegible]		" 12	" 23	66	24	Good.
28	Early Rose	"	120	" 25	" 12	" 24	83½	2[illegible]	"
29	Early Electric	"	76	July 6	" 1	" 24	55	8	"
30	Early Standard	"	120	June 27	" 12	" 24	70	22	"
31	Early Oxford	"	99	" 25	" 12	" 24	83½	14½	Medium.
32	Early Washington	"	120	July 8	" 12	" 24	66¾	24	Good.
33	Eight Weeks	"	120	June 29	" 12	" 24	65¼	19½	"
34	Empire State	"	120	" 25	" 15	" 24	69¼	11	Inferior.
35	Excelsior	"	78		" 15	" 24	41	13¼	"
36	Everitt	"	86	July 4	" 17	" 24	33½	6½	"
37	Fillbasket	"	[illegible]2	" 2	" 17	" 24	23	2½	"
38	Farina	"	102	" 4	" 15	" 24	60	12½	Good.
39	Garfield	"	120	June 25	" 12	" 25	115½	13	Medium.
40	Great Eastern	"	120	July 12	" 20	" 25	76	12½	Inferior.
41	Gold Flesh	"	82	" 17	" 19	" 25	60	15	Good.
42	Gregory's No. 1	"	74	June 25	" 19	" 25	65½	14½	"
43	Hale's Early Peach-blow	"	120	July 4	" 20	" 25	99	10	Medium.
44	Hamden Beauty	"	92	June 27	" 17	" 25	73½	17½	Good.
45	Howe's Premium	"	1		" 12	" 25	13	2	"
46	Howe's Comfort	"	93	July 1	" 15	" 25	86½	11	Extra.
47	Hall's Peach-blow	"	41	" 2	" 15	" 25	35	4½	Good.
48	Improved White Rose	"	120	" 8	" 19	" 25	78	15¾	Inferior.
49	Irish Champion	"	66	" 12	" 19	" 25	69	11½	Medium.
50	Improved Irish Cup	"	90	June 29	" 19	" 26	70	16	"
51	Jackson White	"	120	July 1	" 20	" 26	110¾	9½	Inferior.
52	John Emerson's Seedling	"	39	" 4	" 16	" 26	27	12	Good.
53	Junkis	"	93	" 8	" 16	" 26	81½	16	Inferior.
54	Jumbo	"	120		" 16	" 26	87¾	9	Medium.
55	Jerrard's California Seedling	"	5	" 3	" 12	" 26	4	1	"
56	Lees' Favorite	"	120	June 27	" 12	" 26	121	19	Good.
57	Late Beauty of Hebron	"	120	" 27	" 16	" 26	150½	11½	Medium.
58	Morning Star	"	120	July 4	" 15	" 26	125	10	Good.

Number.	Name of Potatoes.	Date of planting.	Number of hills.	Date of blossoming.	Date of tops dying.	Date of digging.	Weight of large.	Weight of small.	Quality.
							lbs.	lbs.	
59	Monroe Co. Prize............	May 15	120	July 4	Aug. 10	Sept. 26	127	6	Inferior.
60	Matchless....	"	46	" 8	" 16	" 26	37½	10¾	Good.
61	Minister........................	"	108	June 25	" 13	" 26	136½	24	"
62	Mullally........	"	52	July 10	" 13	" 26	73½	11½	Medium.
63	Manhattan.....................	"	83		" 15	" 26	104	15	"
64		"	112	June 27	" 12	" 26	110½	20	Good.
65	New Wide Awake............	"	120	July 1	" 1	" 26	114	15	Extra.
66	New Queen.......................	"	111	June 27	" 12	" 26	131	10	"
67	Orange Co. White............	"	120	July 4	" 19	" 26	146	21	Medium.
68	O. K. Mammoth Prolific.....	"	120		" 19	" 26	109	19	"
69	Old White Carter..............	"	120	" 2	" 19	" 27	68	19	"
70	Pearl of Savoy................	"	120	June 25	" 20	" 27	96	20	Good.
71	Perfect Peach-blow.....	"	120	July 4	" 20	" 27	135	23	Inferior.
72	Purple Blush..................	"	86		" 16	" 27	74	20	Extra.
73	Putnam's Beauty....	"	96	July 8	" 17	" 27	64	14½	Good.
74	Putnam's Early..............	"	120	June 27	" 12	" 30	122½	19	Medium.
75	Putnam's Select.............	May 16	86		" 12	" 30	77	23¾	Extra.
76	Putnam's New Rose.........	"	109	" 25	" 12	" 30	112¾	14½	Good.
77	Pecan..............	"	78	" 25	" 15	" 30	62½	15	"
78	Perfect Gem...................	"	78		" 15	" 30	80	5½	"
79	Pride of Palestine...........	"	96	July 2	" 17	" 30	98	16	"
80	Queen of the Roses..........	"	120	June 22	" 13	" 30	74	11	Medium.
81	Queen of the Valley..........	"	120	" 27	" 16	" 30	77	10	Good.
82	Rose's Magnum Bonum.....	"	120	July 3	" 13	" 30	78	9½	"
83	Rural Blush.........	"	120	" 1	" 20	" 30	85½	12	"
84	Rochester Favorite..........	"	120	" 12	" 19	Oct. 3	105½	9½	Medium.
85	Red Elephant..................	"	120	June 25	" 16	" 3	74	9½	"
86	Rose's New Giant............	"	120	July 2	" 20	" 3	106	11	Inferior.
87	Rose's Beauty of Beauties..	"	120		" 15	" 3	84	10½	Medium.
88	Rural New Yorker No. 2.....	"	120	" 4	" 17	" 3	46½	9	Inferior.
89	Randall's Beauty............	"	84	" 4	" 16	" 3	70½	22½	Medium.
90	St. Patrick.....................	"	120	" 3	" 19	" 3	73	12½	"
91	Stray Beauties.........	"	120		" 20	" 3	110½	15	Good.
92	Snow Queen.................	"	90		" 20	" 3	51	20	Extra.
93	Seneca Red Jacket...... ...	"	120	" 8	" 16	" 3	79	10½	Medium.
94	Thorburn........................	"	120	June 27	" 12	" 3	104	14¼	Extra.
95	Thorburn Late Rose........	"	120	" 27	" 13	" 3	86	12½	Good.
96	Triumph........................	"	120	July 4	" 12	" 3	87	12	Medium.
97	Thunderbolt.......	"	88		" 16	" 4	79	11	Inferior.
98	Vanguard........................	"	120	" 2	" 12	" 4	77	17½	Good.
99	Vermont Champion...... ...	"	120		" 15	" 4	109	17	Inferior.
100	Watson's Seedling...........	"	120	June 27	" 20	" 4	91½	18	Medium.
101	White Star....................	"	120	July 12	" 16	" 4	102½	15	Inferior.
102	White Elephant	"	120	" 4	" 19	" 4	108½	24	"
103	White Seedling...............	"	120	" 8	" 20	" 4	123½	6	"
104	Windoser's No. 1.....	"	100	" 2	" 12	" 4	39½	6½	Good.
105	Wood Ants.....................	"	78		" 12	" 4	51	19	"
106	Wall's Orange.................	"	120	" 4	" 17	" 4	77	16½	Medium.
107	White Beauty of Hebron....	"	120	June 27	" 15	" 4	113½	15½	Good.

Report of Botanist and Entomologist.

PROF. F L. HARVEY.

The work of the division of Botany and Entomology, the past season, has been in the directions indicated below:

BOTANY.

1. Germination Experiments.—To determine the vitality and purity of seeds sold in Maine.
2. Testing Varieties of Grasses.—To determine their adaptability to Maine.
3. Consideration of Potato Blight.—In an exigency bulletin and more in detail for this Report.
4. A Compilation (for this Report) of results of experiments on Apple Scab, made under the auspices of the Agricultural Department, Washington, D. C.
5. Examination of Fungi affecting Fruits, sent for determination by Fruit Growers.
6. Examination of Weeds, Grasses and other plants sent for determination.
7. Collection of herbarium specimens of grasses and other economic plants.
8. Collection of seeds of weeds and other plants, for use in naming seeds.
9. Paper—"Fungi Injurious to Fruits." Read before the State Pomological Society, and to appear in its Annual Report.
10. Consideration of False Flax and Rib Grass in this Report.

ENTOMOLOGY.

11. An Exigency Bulletin on the Apple Maggot.
12. The Apple Maggot.—An extended article for this Report.
13. Paper—"The Apple Maggot." Read before the Pomological Society at Norway, Me.
14. Preliminary study of a scale insect affecting the elms in Maine.
15. Preliminary study of the White Marked Tussock Moth and the Fall Web Worm.
16. Study of the Codling Moth to learn whether there are two broods in Maine.

MISCELLANEOUS.

17. Answering of many letters about insects, plants, fungicides, insecticides, spraying and spraying apparatus.

18. Article on spraying and spraying apparatus for this report.

That portion of the work mentioned above, which is completed and is of enough importance, is considered below. When comparing the work of this Station in Botany and Entomology with that of others, it should be remembered that the Botanist and Entomologist gives but one-third of his time to Station duties. Mr. F. P. Briggs as Assistant, has rendered efficient service in conducting germination tests, looking after the grass plots, and collecting for the herbarium. Correspondence regarding plants and insects, especially injurious fungi and insects, is solicited. Directions for sending specimens may be found in Station Report, 1888, p. 194, or in Maine Agricultural Report, 1888, p. 158. I desire to thank the citizens of the State for the aid they have given me in the prosecution of my work, and also to thank the Director and other Station officers for their co-operation and encouragement.

GERMINATION EXPERIMENTS.

The germination experiments conducted the past season were a continuation of those performed and reported in 1888 They were conducted by Mr. F. P. Briggs in the same manner and with the same apparatus described in the Annual Report for 1888, p. 102. They were undertaken for two reasons: to test commission seeds, offered for sale in Maine, that were not examined in 1888; and to investigate a complaint from Aroostook County that dealers in that section were selling poor seeds.

For the first purpose we selected seeds put up by J. B. Rice, Cambridge, N. Y.; E. W. Lyman, Springfield, Mass.; A. H. Dunlap & Sons, Nashua, N. H.; and Lewis Atwood, Winterport, Me., and offered for sale on Commission in Orono, Me. The detailed results of these tests are shown in the general table, numbers 151 to 190 inclusive. Below is given a special table showing the seeds tested, the per cent. of each kind that germinated and the average.

Comparative Results of Garden Seeds Tested.

Seeds Tested.	Lettuce.	Cabbage.	Celery.	Parsnips.	Onion.	Turnip.	Tomato.	Radish.	Carrot.	Beet.	Average per cent. germinated.
Rice's, commission	46	90	68	58	81	74	84	88	45	81	71.5
Dunlap's, commission	98	74	10	52	36	79	78	76	56	92	65.1
Atwood's, commission	96	0	58	41	73	62	82	6	57	60	53.5
Lyman's, commission	0	91	32	0	0	4	57	80	22	48	33.4

The above table shows, that Rice's seeds were the best, that Dunlap's were second, Atwood's next and Lyman's much below the others and very poor. Rice's seeds were all good. Dunlap's seeds were all good excepting the celery. Leaving this out the others are nearly equal to Rice's. Atwood's cabbage and radish seed were the poorest tested and *very* poor. Leaving those out the others make a better showing, though inferior to either Rice's or Dunlap's. Lyman's cabbage seeds were the best tested and his radish seeds next best, but all the others were poor and none of the lettuce, parsnip and onion seed sprouted.

Among the seeds obtained from Aroostook County were some put up by the above dealers which has enabled us to farther test their quality. Lyman's seeds are not sold to any extent in Aroostook County. Those of Parker & Wood and Delano Moore, Presque Isle, Me., and Oscar Holloway, Auburn, Me., are sold. They are included in the table given below:

Seeds Tested.	Lettuce.	Cabbage.	Celery.	Parsnip.	Onion.	Turnip.	Tomato.	Radish.	Carrot.	Beet.	Salsify.	Sweet Corn.	Red Clover.	Timothy.	Alsike.	Pea-vine Clover.
Rice's, commission	83	85	23	58	84	72	99	83	46	77	66	85				
Dunlap's, commission	79	48		40	34	70		83	57	81						
Atwood's, commission	31	96		3		79	23	4		44						
Delano Moore's				82		99			82	84		90	81	93		
Oscar Holloway's													89	97	70	94
Parker & Wood's													77	95	76	

The above table confirms the statement regarding the relative quality of Rice's, Dunlap's and Atwood's seeds. The garden seeds of Delano Moore, grown in Aroostook County, showed a high germination per cent. and great vitality, but the timothy and clover seeds were a little inferior to others tested, though good. Those of Oscar Holloway and Parker & Wood did not include garden seeds, but their seeds of forage plants were of excellent quality.

For the purpose of easy comparison we reprint the table showing the result of work done in 1888.

COMPARATIVE RESULTS OF GARDEN SEEDS GERMINATED.

Name.	Chick,s seed in bulk.		Dunning's seed in bulk.		Emerson's commission seeds in packets		Ferry's seeds in packets.		Iowa Seed Company's seeds in packets.		Dept Ag— seeds in packets.	
	Varieties tested.	Average per cent. germinated.	Varieties tested.	Average per cent. germinated.	Varieties tested.	Average per cent. germinated.	Varieties tested.	Average per cent. germinated.	Varieties tested.	Average per cent. germinated.	Varieties tested.	Average per cent. germinated.
Lettuce.....	1	99	1	77	1	10	1	98	-	-	2	90
Turnip	1	76	1	29	1	97	1	71				
Cabbage....	1	69	1	88	1	92	1	73	-	-	4	80
Parsnip	1	44	1	34	1	49	1	70				
Celery......	1	27	1	62	1	48						
Onion.......	1	74	1	62	1	95	1	67				
Beet.........	1	63	1	18	1	77	1	76	1	60		
Carrot	-	-	1	51	1	48	1	60			6	66
Tomato....	-	-	-	-	-	-	-		-		4	58

To investigate the complaints from Aroostook County, seeds were purchased from John Watson, Houlton, Me; E. Merritt & Sons, Houlton, Me.; Chas. Wilson, Houlton, Me.; A. H. Fogg & Co., Houlton, Me.; J. A. Miller, Houlton, Me.; J. F. Hacker, Fort Fairfield, Me.

An examination of the general table Nos. 205 to 293 will show that the most of the seeds sold in Aroostook are Commission Seeds put up by various growers and dealers in and out of the State. The question then is largely what seeds sold in Aroostook are those of reliable growers, and what dealers handle them. The tables show that the garden seeds of Ferry, Rice and Moore have a high germinating power, that Dunlap's seeds are not

quite so good, that only about 50 per cent. of Atwood's seeds will sprout and that Lyman's seeds are very poor. The garden seeds from Delano, Moore were grown in Aroostook County and showing such vitality they give a promising outlook for Maine seed growers.

Remarks.

The most of the seeds offered for sale in Maine are not grown in the State, but are sold by growers outside of the State directly to the farmers, or are sold on commission by dealers in the State. Other seeds grown outside the State are purchased in bulk by wholesale Maine seedsmen and by them retailed loose, or in packets. Reliable seedsmen, in the autumn or winter, gather the seeds not sold by Commission Merchants and replace them by new. The seeds offered by some dealers would indicate that old seed is redistributed. It is to the interest of growers, wholesale dealers and packers to sell good seed, for a reputation can not be sustained with inferior seeds. It is to the interest of Commission Merchants to handle only reliable seeds. Failure of crops from poor seed is liable to create suspicion. The tests made by the Station confirm the judgment of growers, for those seeds found to be poor, are the ones the farmers suspect and the merchants will not recommend. We need no State law to regulate this matter as it will sooner or later regulate itself. Farmers by always selecting good seed will drive poor seed from the market.

The object of testing seeds at the Station is to point out reliable growers and those dealers in Maine who put up, or handle on commission, the seeds of reliable growers. We do not conduct these experiments to test the honesty of seedsmen, but in the interest of both planter and seedsmen, that the grower may know what seeds are reliable and that the dealer may know where to obtain them.

Our tests show that the seeds of some dealers, wherever taken in the State, have a high germinating power, while the seeds of others are *invariably* poor. Most Commission Merchants offer for sale the seeds of several growers, and it is the object of germination tests to show which growers puts up the best seeds. There is not care enough taken by many farmers in the selection of seed. Where no preference is expressed the Merchant is liable to dispose of the poorer seed. Farmers are sometimes in a hurry, and when the seed they usually plant cannot be readily had, they take almost

any kind. The selection of seed should be done before the rush of planting time, when care can be exercised. Our advice to farmers is to never buy seeds of doubtful character, and to dealers never to handle them. By working together, poor seed will be driven from the market, the business of reliable seedsmen become less precarious and the crops of the farmer more certain.

It should be remembered that the seeds tested were germinated under the most favorable conditions, and a larger number sprouted than would grow if planted in the ground. Two things may be learned from this: First, seeds which show a low vitality and germinating power with such favorable conditions would not germinate well in the ground. Second, seeds grown in a warmer climate may nearly all sprout in the germinator, but not come up well when put in the ground, or at least not produce a good crop, because they are not adapted to our climate. Good seeds grown in our latitude, if they could be obtained, would be the best to plant.

Moldy Seeds.

The apparatus used was scalded after each experiment, to destroy all germs of fungoid growth, but the seeds themselves, especially the poorer ones, contained spores which produced mold in two or three days. As seeds sprouted after being covered with mold for more than a week, it was supposed the surface mold did not affect their vitality. But to test the supposition, and also to see if anything could be found that would destroy the spores without injuring the seeds, a solution of corrosive sublimate in alcohol was tried. One part of the solution was diluted with ten thousand parts of water and the seeds dipped in this, then washed with water that had been boiled. In these cases the seeds did not mold nor did the solution injure them in any way as far as could be seen. About the same number sprouted as when the corrosive sublimate was not used. Only a few experiments were tried and these seemed to show, that the solution was neither benificial nor prejudicial to germination, though the mold might affect the growth after sprouting. More extended trials might show different results, and such may be undertaken another year.

Explanations.

In the following tables these abreviations for the growers of seeds are used: Rice, J. B. Rice, Cambridge, N. Y.; Lyman,

E. W. Lyman, Springfield, Mass.; Dunlap, A. H. Dunlap & Sons, Nashua, N. H.; Atwood, Lewis Atwood, Winterport, Me; Dept. Agr., Department Agriculture, Washington, D.C.; Moore, Delano Moore, Presque Isle, Me.; Holloway, Oscar Holloway, Auburn, Me.; P. & W., Parker & Wood; Ferry, D. M. Ferry & Co., Detroit, Mich. Numbers 151 to 190 inclusive were obtained in Orono, all of one dealer. Numbers 193 and 194 are two varieties of Cauliflower seed, sent to the station by H. A. Marsh, Fidalgo, Wash. He claims that the seed can be grown at half the cost of imported seed. It not only shows a great germinating power, but also high vitality, as nearly all the seeds sprouted in two days.

Numbers 205 to 216 were obtained from John Watson, Houlton, Me.; 217 to 246, of E. Merritt & Sons, Houlton, Me.; 247 to 256, of Charles Wilson, Houlton, Me.; 257 to 268, of A. H. Fogg & Co., Houlton, Me.; 269 to 293, of J. A. Miller, Houlton, Me.; 294 to 309, of J. F. Hacker, Fort Fairfield, Me.

RESULTS OF GERMINATION TESTS.

Serial number.	Station number.	DESCRIPTION.	Weight of 100 seeds in grams.	Number of seeds sprouted each day.														Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
				1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th			
		(Commission seeds purchased in Orono, Me.)																		
		LETTUCE.																		
151	165	Early Curled Silesia, Rice	.116	0	0	1	13	12	10	7	0	1	2	0	0	0	0	0	46	
152	166	" " Lyman	.092	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
153	167	" " Simpson, Dunlap	.147	0	13	12	35	4	21	10	0	1	1	0	0	1	0	0	98	4
154	168	Lee's Immense Hardy Green, Atwood	.140	0	51	34	6	3	1	1	0	0	0	0	0	0	0	0	96	2
		CABBAGE.																		
155	169	Fottler's Improved Brunswick, Rice	.413	3	78	5	3	0	0	0	0	0	0	1	0	0	0	6	90	2
156	170	Premium Flat Dutch, Lyman	.405	2	62	14	4	2	2	3	1	1	0	0	0	0	0	5	91	2
157	171	Improved Low Flat Dutch, Dunlap	.339	2	54	14	0	3	1	0	0	0	0	0	0	0	0	15	74	2
158	172	Early York, Atwood	.350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	
		CELERY.																		
159	173	Boston Market, Rice	.044	0	0	0	0	0	7	16	16	16	2	5	4	2	0	31	68	9
160	174	" " Lyman	.043	0	0	0	0	0	4	8	3	2	2	9	5	0	0	68	33	
161	175	" " Dunlap	.050	0	0	0	0	0	0	0	0	1	3	3	3	0	0	80	10	
162	176	" " Atwood	.051	0	0	0	0	0	2	6	18	10	13	4	3	2	0	34	58	11
		PARSNIP.																		
163	177	Long White Dutch, Rice	.371	0	0	0	0	4	15	11	15	7	4	1	0	1	0	40	58	9
164	178	" " " Lyman	.36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	
165	179	" " Smooth, Dunlap	.402	0	0	0	2	11	12	14	4	5	3	0	0	0	1	40	52	10
166	180	" Hollow Crown, Atwood	.392	0	0	0	0	0	10	17	4	3	6	1	0	0	0	28	41	
		ONION.																		
167	181	Yellow Danvers, Rice	.303	6	8	31	27	6	1	0	0	0	0	1	1	0	0	5	81	4
168	182	" " Lyman	.338	0	0	0	0	0	0	0	0	0	0	0	0	0	0	70	0	
169	183	" " Dunlap	.347	6	6	11	14	4	1	0	0	0	0	0	0	0	0	40	36	
170	184	" " Atwood	.290	8	19	12	31	3	0	0	0	0	0	0	0	0	0	0	73	4

RESULTS OF GERMINATION TESTS.—(CONTINUED.)

Serial number.	Station number.	DESCRIPTION.	Weight of 100 seeds in grams.	Number of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
		TURNIP.																		
171	185	Skirving's Purple Top, Rice	.281	0	48	13	5	2	1	2	2	0	0	0	0	1	0	20	74	3
172	186	Carter's Improved, Lyman	.293	0	0	0	0	2	0	0	2	0	0	0	0	0	0	34	4	
173	187	Skirving's Purple Top, Dunlap	.278	1	63	7	2	2	1	0	1	1	0	0	1	0	0	17	79	2
174	188	Shamrock, Atwood	.306	0	31	11	5	4	3	2	2	0	0	3	0	1	0	31	62	6
		TOMATO.																		
175	189	Mikado, Rice	.249	0	3	14	61	5	1	0	0	0	0	0	0	0	0	0	84	4
176	190	Triumph Acme, Lyman	.258	0	1	0	14	36	3	2	0	1	0	0	0	0	0	29	57	5
177	191	Early Perfection, Dunlap	.265	0	0	0	56	16	3	2	0	0	1	0	0	0	0	9	78	4
178	192	Trophy, Atwood	.282	0	0	0	46	27	5	1	2	1	0	0	0	0	0	20	82	5
		RADISH.																		
179	193	Early Scarlet Turnip, Rice	.960	7	68	8	1	2	1	0	1	0	0	0	0	0	0	0	88	2
180	194	London Long Scarlet, Lyman	1.295	1	9	45	18	6	0	0	1	0	0	0	0	0	0	0	80	3
181	195	Early " " Dunlap	1.340	0	32	25	5	5	5	1	3	0	0	0	0	0	0	0	76	3
182	196	" Scarlet Turnip, Atwood	.900	0	0	0	0	4	1	1	0	0	0	0	0	0	0	0	6	
		CARROT.																		
183	197	Improved Long Orange, Rice	.100	0	0	0	29	10	5	1	0	0	0	0	0	0	0	35	45	
184	198	" " " Lyman	.132	0	0	0	5	11	5	1	0	0	0	0	0	0	0	54	22	
185	199	" " " Dunlap	.110	0	0	3	35	10	2	2	1	2	1	0	0	0	0	14	56	6
186	200	" " " Atwood	.106	0	0	3	36	12	4	1	1	0	0	0	0	0	0	21	57	5
		BEET.																		
187	201	Dening's Early Blood, Rice	1.585	0	0	1	30	28	15	2	2	0	0	0	0	2	1	13	81	5
188	202	" " " Lyman	1.481	0	0	0	17	19	6	2	2	1	0	1	0	0	0	30	48	6
189	203	" " " Dunlap	2.445	0	0	0	24	29	27	8	3	0	0	1	0	0	0	4	92	5
190	204	" " " Atwood	2.107	0	0	0	9	25	20	3	2	0	0	1	0	0	0	30	60	6
191	205	Salsify, Rice	1.230	0	0	35	16	1	1	7	3	1	0	0	0	2	0	18	66	4
192	206	" Lyman	1.026	0	0	0	0	1	0	3	1	2	0	0	0	0	0	1	7	

		Sent by H. A. Marsh, Fidalgo, Washington. CAULIFLOWER.																	
193	207	American Snowball, Marsh	.402	3	82	11	0	0	0	0	0	0	0	0	0	0	0	0	96	2
194	208	Erfust Earliest Dwarf, Marsh	.348	1	95	2	1	0	0	0	0	0	0	0	0	0	0	0	99	2
		Obtained from Dep't Agr'l, Washington, D. C. ONION.																	
195	209	Early White Nocera, Department Agriculture	.323	0	2	41	15	4	2	0	0	1	0	1	0	0	0	0	66	4
196	210	New Aduatic Barletta, " "	.400	0	7	11	31	3	1	3	0	0	0	0	0	0	0	6	56	5
197	211	Flat Maderia, " "	.384	0	0	66	12	8	0	1	0	0	2	0	0	0	0	4	89	3
198	212	Giant White Italian Tripoli, " "	.324	0	18	34	16	9	2	0	0	0	1	0	0	0	0	12	80	3
199	213	" Blood Red Racca, " "	.391	0	10	55	15	4	0	0	0	0	1	0	0	0	0	4	85	3
200	214	Early White Queen, " "	.387	0	40	59	0	0	0	0	0	0	0	0	0	0	0	0	99	3
201	215	Mammoth Silver King, " "	.375	0	25	68	4	0	0	0	0	0	0	0	0	0	0	0	97	3
202	216	" Pompeii, " "	.376	4	57	10	2	1	1	0	1	1	1	0	0	0	0	9	78	2
203	217	Giant Yellow Globe Racca, " "	.424	1	9	69	14	8	0	0	0	0	0	0	0	0	0	0	96	3
204	218	White Maggiajola, " "	.312	0	22	51	15	1	0	0	1	0	0	0	0	0	0	0	90	3
		Obtained of John Watson, Houlton, Me.																	
205	219	Hollow Crown Parsnip, Moore	.452	0	0	1	6	23	24	16	8	0	3	1	0	0	0	10	82	6
206	220	Early Eclipse Beet, "	1.528	0	0	0	25	32	20	5	0	1	0	1	0	0	0	8	84	5
207	221	" Cory Sweet Corn, "	29.582	0	0	0	13	45	21	8	1	2	0	0	0	0	0	0	90	5
208	222	Ox-heart Carrot, "	.143	0	5	62	13	1	2	0	0	0	0	0	0	0	0	0	83	3
209	223	American Ruta Baga Turnip, Moore	.293	90	5	4	0	0	0	0	0	0	0	0	0	0	0	0	99	1
210	224	Danvers' Carrot, "	.102	40	30	10	0	1	0	0	0	0	0	0	0	0	0	0	81	2
211	225	Red Clover, "	.175	35	35	9	2	0	0	0	0	0	0	0	0	0	0	0	81	2
212	226	Timothy, "	.038	0	28	32	33	0	0	0	0	0	0	0	0	0	6	0	93	3
213	227	Red Clover, Holloway	.145	51	20	18	0	0	0	0	0	0	0	0	0	0	0	0	89	1
214	228	Timothy, "	.032	0	24	56	16	1	0	0	0	0	0	0	0	0	0	0	97	3
215	229	Alsike Clover, "	.058	43	20	6	1	0	0	0	0	0	0	0	0	0	0	9	70	2
216	230	Pea-vine Clover, "	.165	70	20	4	0	0	0	0	0	0	0	0	0	0	0	0	94	1
		E. Merritt & Sons, Houlton, Me.																	
217	231	Sweet Fodder Corn, P. & W	19.000	0	0	3	36	25	5	1	0	0	1	1	0	0	0	0	72	5
218	232	Sanford Field Corn, "	36.725	0	0	3	42	24	1	2	1	0	0	0	0	0	0	0	73	5
219	233	Marblehead, "	23.152	0	0	0	18	31	17	2	0	0	0	0	0	0	0	0	68	6
220	234	Crosby's Early Sweet, Rice	21.130	0	0	1	35	29	8	1	2	0	0	0	0	0	0	0	76	5
221	235	Red Clover, P. & W	.173	7	20	30	7	6	4	2	1	0	0	0	0	0	0	12	77	3
222	236	Alsike " "	.056	40	20	13	0	2	1	0	0	0	0	0	0	0	0	0	76	2
223	237	Timothy, "	.033	0	30	38	27	0	0	0	0	0	0	0	0	0	0	0	95	3
224	238	Dewing's Blood Turnip Beet, Dunlap	2.210	0	0	0	19	35	16	3	6	0	0	1	1	0	0	9	81	5
225	239	" " " Ferry	2.30	0	0	0	10	23	37	11	3	1	1	0	0	0	0	7	86	6
226	240	Long Smooth Parsnip, Dunlap	.388	0	0	0	1	8	9	12	7	2	2	1	0	1	0	50	43	
227	241	" Flat Dutch " Ferry	.392	0	0	0	1	5	10	16	7	8	2	3	2	0	0	37	54	11
228	242	Early Prize Head Lettuce, Dunlap	.150	0	14	2	13	9	10	4	4	5	8	0	1	0	0	22	70	6
229	243	White Head Lettuce, Ferry	.118	0	78	1	1	0	1	2	0	0	0	0	0	0	0	[illegible]	83	2
230	244	Stone Mason Cabbage, Dunlap	.341	0	10	16	7	3	4	3	3	0	1	1	0	0	0	0	48	
231	245	Late Flat Dutch " Ferry	.330	1	29	61	1	1	2	0	0	0	0	0	0	0	0	3	95	3
232	246	Long Orange Carrot, Dunlap	.095	0	8	15	23	2	6	3	0	0	0	0	0	0	0	0	57	6

RESULTS OF GERMINATION TESTS.—(CONTINUED.)

Serial number.	Station number.	DESCRIPTION.	Weight of 100 seeds in grams.	Number of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
233	247	Long Orange Carrot, Ferry	.118	0	4	12	25	9	3	2	2	0	0	0	0	0	0	15	57	5
234	248	Purple Top Turnip, Dunlap	.200	3	10	21	14	3	4	2	0	0	0	0	0	0	0	0	57	5
235	249	" " " Ferry	.280	0	10	32	11	4	5	3	0	0	0	0	0	0	0	0	65	4
236	250	Phinney's Early Watermelon, Dunlap	3.600	0	0	0	0	0	3	38	10	1	0	0	0	0	0	48	52	8
237	251	Mountain Sprout, " Ferry	4.512	0	0	0	6	20	56	0	4	0	0	0	0	0	0	10	86	6
238	252	Early Red Globe Onion, Dunlap	.368	4	16	10	2	0	0	0	0	0	0	0	0	0	0	15	32	
239	253	" Long Scarlet Radish, Ferry	1.412	1	54	6	3	3	1	0	0	0	0	0	0	0	0	0	68	2
240	254	Five varieties Radish, Rice	.918	7	68	6	1	1	0	0	0	0	0	0	0	0	0	0	83	2
241	255	Livington's Perfection Tomato, Ferry	.292	0	0	4	36	20	4	4	0	2	0	2	0	0	0	40	72	5
242	256	New Dwarf Champion " Rice	.298	0	0	30	61	4	3	1	0	0	0	0	0	0	0	0	99	4
243	257	Tupple Curled Parsley, Ferry	.175	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
244	258	Burple's Ruby King Pepper, Rice	.675	0	0	0	0	0	2	4	10	8	2	1	1	0	0	72	28	
245	259	Gregory's Early Mammoth Cabbage, Rice	.33	50	25	8	2	0	0	0	0	0	0	0	0	0	0	0	85	1
246	260	White Plume Celery, Rice	.040	0	0	0	0	2	10	7	3	1	0	0	0	0	0	28	23	
		Purchased of Chas. Wilson, Houlton, Me.																		
247	261	Long Dark Blood Beet, Atwood	1.834	0	0	2	18	12	7	3	2	0	0	0	0	0	0	52	44	
248	262	Mountain Sweet Watermelon, Atwood	10.510	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
249	263	Student Parsnip, "	.410	0	0	0	0	0	0	1	0	0	2	0	0	0	0	94	3	
250	264	Golden Ball Turnip, "	.198	0	20	32	17	7	6	3	0	0	0	0	0	0	0	0	85	3
251	265	Skirving's Purple Top Turnip, "	.275	13	20	14	6	9	8	4	1	1	2	1	0	0	0	8	72	3
252	266	Early Scarlet Radish, "	.900	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	4	
253	267	English Broad Leaved Sage, "	.724	0	0	0	0	0	0	1	2	2	0	1	0	0	0	90	6	
254	268	Flat Dutch Cabbage, "	.285	1	74	13	3	2	1	2	0	0	0	0	0	0	0	0	96	2
255	269	Smooth Red Tomato, "	.330	0	0	0	0	1	3	4	3	5	5	2	0	0	0	8	23	

256	270	Curled Silesia Lettuce	.150	0	10	3	1	13	1	0	0	0	2	0	0	0	0	26	30	
		Purchased of A. H. Fogg & Co., Houlton, Me.																		
257	271	Blood Turnip Beet, Rice	1.550	0	0	0	17	24	20	5	1	2	1	1	0	0	0	22	71	6
258	272	Long White Dutch Parsnip, Rice	.417	0	0	0	[illegible]	0	3	13	18	11	5	5	2	1	0	42	58	10
259	273	Simpson Lettuce, "	.164	0	63	3	10	4	2	1	0	0	0	0	0	0	0	14	83	2
260	274	Evergreen Sweet Corn, "	22.176	0	0	3	22	30	29	7	2	1	0	0	0	0	0	0	94	5
261	275	Wethersfield Red Onion, "	.341	10	32	39	7	4	1	0	1	0	0	0	0	0	0	3	94	3
262	276	Flat Dutch Turnip, "	.210	12	15	22	14	3	4	2	0	0	0	0	0	0	0	10	72	4
263	277	Early Scarlet Radish, "	.880	5	70	4	3	0	0	0	0	0	0	0	0	0	0	0	82	2
264	278	Henderson's Early Cabbage, "	.413	56	24	12	1	1	0	0	0	0	0	0	0	0	0	0	94	1
265	279	Short Horn Carrot, "	.125	0	0	10	23	6	5	2	0	0	0	0	0	0	0	20	46	
266	280	White Clover,	.054	51	26	4	1	1	0	0	0	0	0	0	0	0	0	0	83	1
267	281	Alsike "	.062	36	12	10	4	3	1	0	0	0	0	0	0	0	0	30	66	4
268	282	Red "	.145	45	30	14	0	0	0	0	0	0	0	0	0	0	0	0	89	2
		Purchased of J. A. Miller, Houlton, Me.																		
269	283	Stowell's Evergreen Sweet Corn, Ferry	22.576	0	0	1	28	40	28	2	0	0	0	0	0	0	0	0	99	5
270	284	New Cory Sweet Corn, Rice	21.428	0	0	0	5	38	21	14	5	3	1	0	0	0	0	0	87	6
271	285	Dark Red Eclipse Beet, "	2.237	0	0	12	50	11	10	1	0	0	0	0	0	0	0	16	84	4
272	286	Mammoth Cabbage Lettuce, Rice	.173	0	81	5	4	1	0	0	0	0	0	0	0	0	0	0	91	2
273	287	New Volunteer Tomato, "	.337	0	11	65	13	2	0	0	0	0	0	0	0	0	0	0	91	3
274	288	Burpee's Ruby King Pepper, "	.666	0	0	0	0	0	1	8	5	5	2	1	2	1	0	75	25	
275	289	Blood Turnip Beet, Dunlap	1.450	0	0	0	20	24	15	8	3	0	2	0	1	0	0	15	73	6
276	290	Silver Leaf Beet, "	1.770	0	0	0	23	36	11	8	1	2	0	1	0	0	0	14	82	5
277	291	Winingstadt Cabbage, "	.312	0	0	4	2	2	2	5	3	2	2	2	1	0	0	75	25	
278	292	Purple Top Turnip, "	.304	80	2	2	3	2	1	0	0	0	0	0	0	0	0	0	90	1
279	293	Early Scarlet Radish, "	1.421	0	68	8	1	3	2	1	0	0	0	0	0	0	0	0	83	2
280	294	" Red Globe Onion, Dunlap	.323	3	17	15	1	0	0	0	0	0	0	0	0	0	0	12	36	
281	295	" Prize Head Lettuce, "	.168	0	9	7	22	27	5	2	0	6	4	0	0	0	0	0	82	5
282	296	White Smooth Parsnip, "	.418	0	0	0	0	4	8	9	7	5	3	1	0	0	0	63	37	
283	297	Blood Turnip Beet, Ferry	2.120	0	0	1	6	30	33	7	9	0	0	1	2	0	0	11	89	6
284	298	Long Orange Carrot, "	.122	0	0	15	14	8	2	2	3	0	0	0	2	1	0	10	47	
285	299	Yellow Montanagny Turnip, Ferry	.302	7	28	30	30	3	1	0	0	0	0	0	0	0	0	0	99	3
286	300	Strap Leaved Turnip, "	.308	73	10	4	1	1	0	0	0	0	0	0	0	0	0	0	89	1
287	301	Winingstadt Cabbage, "	.310	4	79	5	1	0	1	0	1	1	1	0	0	0	0	0	93	2
288	302	Crawford's Half Dwarf Celery, Ferry	.038	0	0	0	0	2	3	7	3	4	2	1	1	0	0	40	23	
289	303	Early Scarlet Radish, "	1.43	34	33	3	1	0	0	0	0	0	0	0	0	0	0	0	71	2
290	304	Peerless Watermelon, "	9.623	0	0	0	0	20	30	10	4	0	2	0	0	0	0	34	66	6
291	305	Long White Dutch Parsnip, "	.421	0	0	0	0	2	11	15	6	3	1	2	0	0	0	0	40	
292	306	Sweet Mountain Pepper, "	.660	0	0	8	20	15	5	3	5	5	2	3	1	0	0	0	67	8
293	307	Trophy Tomato, "	.314	0	54	29	3	1	1	0	2	0	0	0	0	0	0	0	90	2
		Purchased of J. F. Hacker, Fort Fairfield, Me.																		
294	308	Alsike Clover	.064	43	30	9	2	0	0	0	0	0	0	0	0	0	0	0	84	2
295	309	Red Clover	.147	20	20	15	5	1	1	0	0	0	1	0	0	0	0	0	63	3
296	310	Timothy	.041	2	14	20	38	3	3	2	0	0	0	0	0	0	0	0	82	4
297	311	"	.041	0	9	30	44	6	2	0	0	0	0	0	0	0	0	0	91	4
298	312	Red Clover	150	0	4	9	9	4	2	1	0	0	0	0	0	0	0	0	29	

RESULTS OF GERMINATION TESTS.—(CONTINUED.)

Serial number.	Station number.	DESCRIPTION.	Weight of 100 seeds in grams.	Number of seeds sprouted each day. 1st	2d	3d	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Sound seeds left.	Per cent. sprouted.	No. of days required for one-half to sprout.
299	313	Timothy	.040	0	20	36	35	0	1	0	0	0	0	0	0	0	0	0	92	3
300	314	Ruta Baga Turnip, Ferry	.305	16	65	5	3	3	1	0	0	0	0	0	0	0	0	6	93	2
301	315	Purple Top " "	.302	0	28	17	5	2	3	4	2	1	0	0	1	0	0	12	63	4
302	316	Jersey Wakefield Cabbage, Ferry	.313	52	33	0	0	0	0	0	0	0	0	0	0	0	0	7	85	1
303	317	Winingstadt " "	.309	6	52	8	2	0	0	0	0	0	0	1	0	0	0	0	69	2
304	318	Blood Turnip Beet, "	2.213	0	0	28	43	15	2	1	0	0	0	1	0	0	0	0	90	4
305	319	Dark Red Eclipse Beet, Rice	2.014	0	1	25	17	6	2	0	1	0	0	0	1	0	0	0	53	6
306	320	Drumhead Cabbage, "	.321	4	41	1	0	0	0	0	0	0	0	0	1	0	0	0	47	
307	321	Blood Turnip Beet, Dunlap	2.441	0	0	32	27	4	1	1	1	1	2	0	0	0	0	0	69	4
308	322	Red Globe Onion, "	.298	0	19	9	1	1	1	2	0	0	0	0	0	0	0	0	33	
309	323	White Smooth Parsnip, Dunlap	.402	0	0	0	3	21	9	8	1	2	3	0	0	0	0	0	47	

EXPERIMENTS WITH FORAGE PLANTS.

In the spring of 1888, about seventy varieties of grasses and other forage plants were sown in plots. Some of these failed to grow; others grew the first season and winter killed, while a number proved to be duplicates. Those that grew more or less satisfactorily are below considered. Those that seem promising will be further tested in larger plots under the most favorable conditions of soil and moisture and the yield per acre recorded.

GRASSES.

1.	Brown Bent,	*Agrostis canina*
2.	Red Top,	" *vulgaris*
3.	Creeping Bent,	" *stolonifera*
4.	Meadow Fescue,	*Festuca pratensis*
5.	Tall "	" *elatior*
6.	Sheep "	" *ovina*
7.	Hard "	" *dunuscula*
8.	Wood Meadow,	*Poa nemoralis*
9.	Kentucky Blue,	" *pratensis*
10.	Rough-stalked Meadow,	" *trivialis*
11.	English Blue,	" *compressa*
12.	Fowl Meadow,	" *serotina*
13.	Rescue Grass,	*Bromus unioloides*
14.	Meadow Brome,	" *pratensis*
15.	Soft Chess,	" *mollis*
16.	Slender Foxtail,	*Alopecuris agrostis*
17.	Rye Grass,	*Lolium perenne*
18.	Tall Oat-grass,	*Arrhenatherum avenaceum*
19.	Sweet Vernal,	*Anthoxanthum odoratum*
20.	Timothy,	*Phleum pratense*
21.	Velvet Grass,	*Holcus lanatus*
22.	Orchard "	*Dactylis glomerata*
23.	Reed Canary,	*Phalaris arundinacea*
24.	Crested Dogstail,	*Cynosurus cristatus*

CLOVER.

25.	Alsike,	*Trifolium hybridum*
26.	Red,	" *pratense*
27.	White,	" *repens*
28.	Crimson,	" *incarnatum*

MISCELLANEOUS.

29.	Sweet Clover,	*Melilotus alba*
30.	Honey, "	" *caeruleus*
31.	Alfalfa,	*Medicogo sativa*
32.	Black Medic,	" *lupulina*
33.	Sainfoin,	*Onobrychis sativa*
34.	Small Pea,	*Lathyrus sativus*
35.	Hairy Vetch,	*Vicia villosa*
36.	Birds-foot Clover,	*Lotus corniculatus*
37.	Serradella,	*Ornithopus sativus*
38.	Tarweed,	*Madia sativa*
39.	Giant Spurry,	*Spergula maxima*

Notes on Grasses and Forage Plants.

1. Brown Bent Grass.—This grass is sometimes called Mountain Red Top, on account of its growing naturally on hills and mountains, and is reported as being a slender grass 6 to 12 inches high. In the plot it grew about 18 inches, which was of course due to the greater fertility of the soil. It could not produce a large crop of hay even on very rich ground, but is valuable as a pasture grass. It came into full bloom June 28.

2. Red Top.—This is probably the most valuable of the Bent grasses. It made a good growth although the soil must have been rather dry for it, as it prefers moist land. It has a strong, erect stem, and is a good grass to sow on swampy ground with Fowl Meadow, to prevent the latter from lodging. It attained a height of nearly three feet, and sown with clover or other grasses would give a good crop of hay. It blossomed July 1, a little later than the other Bent grasses.

3. Creeping Bent.—A grass described as growing to the height of 24 inches on wet land. Ours was only 14 inches high, owing to dry soil, and was a fine grass, with thick bottom. It blossomed June 28. It would be useless to sow on up-lands, but is said to produce a good crop on swampy meadows.

4. Meadow Fescue.—This is a valuable grass for either hay or pasture. It is one of the earliest to start in the spring, and comes to maturity in good season, June 21 being the date of full bloom. Unlike most grasses the stalks and leaves remain green till it ripens its seed. It grows on either dry or wet soil, gravel,

loam, or clay, and its long roots enable it to withstand droughts. To obtain the seed pure is a difficult matter, as it is often adulterated with Rye grass, hence one needs to exercise care in purchasing. It grew 3 feet high. This grass deserves a trial in Maine.

5. Tall Fescue.—Very much resembles the grass just mentioned, being a little larger. It has the same habits of adapting itself to any kind of soil. A chemical analysis shows it to be very nutritious. It has a tendency to grow in tufts like most of the Fescue grasses. Produces a large crop of hay on rich ground, sometimes growing 4 or 5 feet high, but in our plot measured three feet. Blossomed June 28.

6. Sheep Fescue.—Said to be an excellent pasture grass, especially for sheep. It grows in bunches, having a large mass of small nearly cylindrical leaves from the root, and a few slender stems, of which the highest measured 16 inches. When sown thickly it forms a very dense bottom, which furnishes a good bite for stock, but is too fine for hay. Came into full bloom June 12.

7. Hard Fescue.—Resembles Sheep's Fescue, being a little larger, and like it, grows on dry hills. What was said of that, will also apply to this species. It grew 18 inches high, and blossomed June 13.

8. Wood Meadow Grass.—This grass grows in moist shady places, two feet or more in height. In the plot it was about 18 inches high, and rather slender. It blossomed June 28. Not much of the seed sprouted, consequently the plants were scattered, and as the ground was hardly suitable for it, one could not tell what it would do under favorable conditions. It has not been cultivated much, probably on account of its growing best in the shade.

9. Kentucky Blue Grass.—A great deal has been written concerning Kentucky Blue Grass, some claiming it to be the most valuable, others saying it is one of the most worthless of the tame grasses. It is certainly a nutritious grass, especially before blossoming, but deteriorates rapidly as it grows older. It is one of the first to blossom, June 12 being the date of full bloom, hence needs to be cut early, and therefore cannot be sown with many other grasses. Our tallest plants measured 21 inches, but it is often higher than this. It has an abundance of long leaves from the root.

10. Rough-Stalked Meadow Grass.—As its name implies this is a grass growing in wet meadows, having a rough stem, by which it may be distinguished from most of its genus. It blossomed June 28, and measured 27 inches, which is below its natural height. It is recommended for shady pastures.

11. English Blue Grass.—A grass found growing on dry, sandy or gravelly knolls, and hence of some value for dry pastures. It is sometimes called Wire grass as it has a tough, hard stem which is difficult to cut. The spike has a purplish or bluish tinge, and the leaves are a bluish-green, so that it well deserves the name of Blue grass. It grew larger than it is usually found in its wild state, being 20 inches high. Blossomed June 30.

12. Fowl Meadow Grass.—This species is well known to farmers who have swampy meadows. It produces a heavy crop of hay, often three tons or more to the acre. Unlike most grasses it keeps green long after blossoming. It has a tendency to lodge badly, but instead of decaying it sends up shoots from the joints, which keep the stalks green. It should be harvested before lodging, however, as it is then much easier to cut. This grass generally gives way in time to the coarser water grasses and sedges, and needs to be resown. It is perhaps the most valuable of our wet meadow grasses. It grew in dry soil 30 inches high, and blossomed June 30.

13, 14, 15. Brome Grasses.—The seeds of all these grasses were poor and but few plants were obtained. The cheat or chess, often found growing as a weed in grain fields, belongs to this genus. The only one that has any claim as a cultivated grass is the Rescue grass, which is grown for winter pasturage in the south. It would be of no value here. The farmer should treat them as weeds, and prevent them from getting a foot-hold in his fields, if possible.

16. Slender Foxtail.—The Foxtail grasses bear some resemblance to Timothy, having, like it, a cylindrical spike. They grow naturally in moist bottom lands. This species has purplish heads and the stalks near the ground are of the same color. It blossomed early, June 13, and made a good growth for dry soil, 22 inches. It is not generally recommended but we consider it worth a trial.

17. Rye Grass.—A perennial grass cultivated for many years in Europe, and considered one of their best grasses, but in this

country has not met with so much favor It has numerous leaves from the root, and an erect, dry, wiry stem 20 inches high, with a long undulating spike, somewhat resembling our common Witch grass (*Agropyrum repens.*) It blossomed July 3.

18. TALL OAT GRASS.—This grass is said to often attain a height of 6 feet; in our plots it was a little over three. It bears a resemblance to our common oat, though is smaller in every way except in height. It will produce two crops in a season, and many declare it to be an excellent grass, while others say it is bitter, liable to smut, and difficult to eradicate. It needs to be tested farther before it can be recommended. Blossomed June 21.

19. SWEET VERNAL GRASS.—A common grass in old fields and pastures, and one of the earliest to blossom, June 13 being the date of our plot. It is fragrant when drying and gives a pleasant odor to new mown hay. It is too small for a hay crop, being less than two feet high. Our plants were only a foot high, owing to the seed being sown too thickly.

20. TIMOTHY.—Also called Herd's grass, and too well known to need any description. Is generally considered one of our best grasses, although a chemical analysis shows that there are many others more nutritious. The height varies greatly according to the fertllity of the soil. Our plants were 3 feet. It blossomed June 21. It should be cut early as it grows woody rapidly after blossoming.

21. VELVET GRASS.—A pretty grass with an abundance of velvety leaves from the root, and a soft purplish spike. Grows best on moist land, but will adapt itself to any soil. Said to be of no value as an agricultural grass as cattle do not relish it. Blossomed June 21, and grew 18 inches high.

22. ORCHARD GRASS.—A tall grass growing in bunches, and furnishing a large crop of hay when sown thickly or with other grasses. It starts quickly after mowing and produces a good aftermath. It blossomed June 13, about the same time as Red Clover, and these two sown together will give two crops of excellent hay in a season. It grew 4 feet high. It deserves to be grown more in this State.

23. REED CANARY GRASS.—This is a tall, coarse grass found in wet places; not much value as hay unless cut very early. It may be mown two or three times in a season, as it is a rapid grower. One plot produced a growth of leafy stems about 2 feet

high, but did not blossom although allowed to grow till late in the season, the soil evidently being too dry. It grows 4 feet or more high, in swampy ground.

24. CRESTED DOGSTAIL.— A dry, wiry, light colored grass with slender stem and small spike. Not much value except in dry pastures. Grew in plot 22 inches high. Blossomed July 3. The straw is used for braiding.

25, 26, 27. ALSIKE, RED AND WHITE CLOVER.—These are well known and considerably cultivated all over the State. The first two make excellent hay, and the last furnishes good pasturage. The height, and time of blossoming is given to compare with the grasses. All in full bloom June 10. The heights were 24, 30, and 12 inches, respectively.

28. CRIMSON CLOVER.—Also called Scarlet, French, Italian, and Incarnate clover. Unlike the three above, it is an annual, and therefore cannot be used for seeding down. For this reason it is not cultivated very extensively in the North. It has more elongated heads than the Red clover, which are a bright crimson. It was sown June 1, and blossomed Sept. 1, following. Height 26 inches.

29. SWEET CLOVER.—Not a true clover, but closely connected. A tall, busy plant often found growing wild. Perhaps of some value as a fodder if cut when small. Blossomed July 3; tallest plants, 8 feet.

30. HONEY CLOVER.—An annual, growing 18 inches high, and having numerous heads of blue flowers, which furnish considerable honey to bees; of more value for this purpose than for a fodder.

31. ALFALFA OR LUCERNE.—A deep rooted, erect plant, 2 to 3 feet high, growing best in a dry, sandy soil. It has a branching, leafy stem bearing a dense raceme of blue flowers. It must be cut while young, as it soon becomes woody. A number of crops can be obtained the same season, and it is said to produce an immense amount of rich fodder year after year. It stands drought well on account of its long roots which it sends into the ground 12 or 15 feet deep. Two or three years are required for it to become well established, which perhaps accounts for its not being cultivated more extensively in the North. It deserves a thorough trial in Maine.

32. BLACK MEDIC.—The seed of this was obtained under the name of Yellow Trefoil. It is a small, half trailing plant with

heads of yellow flowers. It is not large enough to produce much fodder, and would hardly be worth cultivating. Blossomed June 25; over one foot high.

33. Sainfoin.—This plant is said to grow well on poor, run out land, and in Europe is used for soiling to considerable extent. It is a straggling plant from a hard, woody tap root, having pinnate leaves and a spike of handsome purple flowers. Under favorable conditions grows 3 feet high, but in our plot only 15 inches. Blossomed June 13.

34. Small Pea.—The seed of this, and of the next three plants was received from the Department of Agriculture, and we give the description accompanying the seed:

"Extensively cultivated in Southern Europe, for its seed, which is eaten in the same way as the Chick Pea, but it is of superior quality; the pod is also eaten green and the whole plant is sometimes cut for forage, while the peas are much given to poultry."

It resembles the common pea, being smaller; 20 inches high. Planted June 1, blossomed Aug. 20.

35. Harvy Vetch.—"A native of Persia and the borders of the Caspian Sea, but is cultivated extensively in almost every quarter of the globe. Its roots are diuretic, while its seeds, in spite of their nutritious qualities, are not wholly destitute of poisonous ingredients."

Very much resembles our common vetch, (*Vicia Cracca.*) Grew about 2 feet high. Blossomed Aug. 30. Planted same time as one preceding.

36. Birds-foot Clover.—"Is found in the greater part of Europe, in Northern Africa, Northern Central Asia, and in Australia. The larger varieties form a very good ingredient in our pastures and meadows."

Our plants were 14 inches high. They had a tap root, sending up numerous branches with bright yellow flowers. Blossomed June 25.

37. Serradella.—"A native of Portugal, is a valuable agricultural plant, introduced in 1818, and particularly worthy of attention from the fact of its producing an abundant crop of excellent fodder where nothing else will grow to perfection. It is an annual."

This is a branching, leafy plant, having small, purplish flowers. We only obtained a few specimens, and these were scarcely a foot high. Planted June 1, and blossomed Aug. 27.

38. Tarweed.—This belongs to the Composite family, the same as our common dandelion and white weed. It is a stout, erect plant, 3 feet high, with numerous lanceolate leaves, and yellow flowers. The stem is covered with glandular hairs which exude a viscid substance making it exceeding sticky, from which it has received the name of Tarweed. When green it has a strong, heavy odor due to some volatile liquid which is dissipated in drying. It is an annual, and seeds itself if allowed to mature. Blossomed Aug. 27.

39. Giant Spurry.—The following accompanied the seed:

"Grown to serve as pasture for cattle, imparting a fine flavour to mutton, and enriching the milk of cows. Its foliage is of a pleasant green color and delicate texture; it soon establishes itself, and possesses the recommendation of retaining its verdure in the dryest and hottest season."

This is very much like the common spurry, (*Spergula arvensis*,) which is a weed in crops, and seems to have the same habits. It continues to blossom and ripen its seeds all the season, thus producing an enormous quantity, which sprout and grow very readily. It doubtless has some good qualities, but once introduced it would be difficult to get rid of, and should therefore be treated as a weed. Blossomed July 25, two months from sowing. Height 15 inches.

Remarks.

The hay crop in this State is our most valuable one. It can easily be increased in quantity, and improved in quality. Some of the best grasses and forage plants are scarcely cultivated in Maine, and it is the purpose of the Station to test their adaptability to our soil and climate, and call the attention of farmers to those that seem worthy of cultivation. We quote from two writers as follows: "The importance of introducing new grasses, and efforts to improve those already cultivated, cannot be over-estimated. It is not at all certain that we have the best kinds, nor that those we have are brought to the greatest degree of perfection. Doubtless they may be improved, as well as fruits and live stock."

"A dozen sorts, probably, cover nineteen-twentieths of all the meadow land from Maine to Texas. It can hardly be supposed that so limited a number meets, in the best manner possible, all

the wants of so great a variety of soil and climate. This is one of the pressing wants of our agriculture. A single new grass that would add but an extra yield of a hundred lbs. to the acre, would add millions of dollars annually to the productive wealth of the nation."

When we remember that there are over three thousand different grasses, and a great many other plants valuable for hay and grazing, we can easily see the chances for improvment in this direction. Our experiments have not been carried on long enough to enable us to recommend with certainty, many new grasses. We would suggest the following for the purpose named:

HAY ON UPLANDS.

Timothy,	*Phleum pratense*
Red Top,	*Agrostis vulgaris*
Tall Fescue,	*Festuca elatior*
Meadow Fescue,	" *pratensis*
Orchard Grass,	*Dactylis glomerata*
Alsike Clover,	*Trifolium hybridum*
Red Clover,	" *pratense*
Alfalfa,	*Medicago sativa*

HAY ON WET MEADOWS.

Fowl Meadow,	*Poa serotina*
Red Top,	*Agrostis vulgaris*
Creeping Bent,	" *stolonifera*
Tall Fescue,	*Festuca elatior*

DRY PASTURES.

Brown Bent,	*Agrostis canina*
Sheep Fescue,	*Festuca ovina*
Hard Fescue,	*Festuca dunuscula*
Blue Grass,	*Poa compressa*
White Clover,	*Trifolium repens*

MOIST OR SHADY PASTURES.

Creeping Bent,	*Agrostis stolonifera*
Rough-stalked Meadow,	*Poa trivialis*
Meadow Fescue,	*Festuca pratensis*

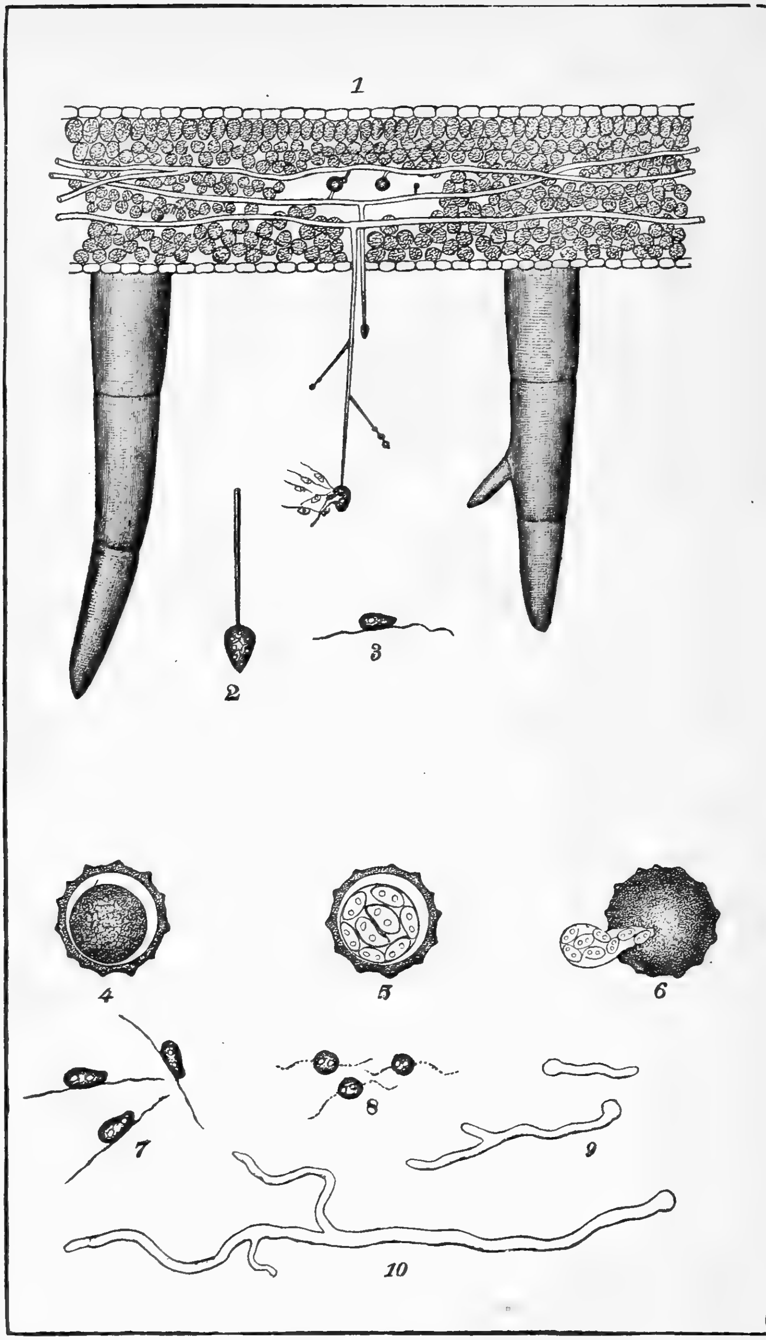
INJURIOUS PLANTS.

Plants of Economic Importance Received for Examination in 1889.

	COMMON NAME.	SCIENTIFIC NAME.	DEPREDATIONS.
		PARASITIC FUNGI.	
1	Potato Rot, Rust, Blight	*Phytophthora infestans*,	On potato vines and tubers.
2	Apple Scab, or Black Spot	*Fusicladium dendriticum*,	On apple stems, leaves and fruit.
3	Bitter Rot	*Gloeosporum versicolor*,	On apples.
4	Scarlet Rot		On apples.
5	Pear Blight	*Micrococcus amylovorus*, *Bur*	On pear twigs and leaves.
6	Downy Mildew, Gray Rot	*Peronospora viticola*,	On grape leaves and fruit.
7	Powdery Mildew	*Uncinula ampelopsidis*, *Pk*	On grape leaves.
		WEEDS.	
8	Pigweed, or Green Amarantus	*Amarantus retroflexus*, *L*	Weed in garden.
9	False Flax, or Gold of Pleasure	*Camelina Sativa*. *Crantz*	" " fields.
10	Black Bindweed	*Polygonum convoloulus*, *L*	" " garden and fields.
11	Rib Grass, English Plantain	*Plantago lanceolata*, *L*	" " fields.
12	Downy Vetch	*Vicia Cracca*. *L*	" " "
13	Wild Pink	*Silene Pennsylvanica*	" " garden.
14	Fall Dandelion	*Leontodon autumnale*, *L*.	" " meadows.

Remarks.

Besides the plants mentioned above quite a number of specimens of no special economic importance have been examined and reports made directly to the parties sending them. The Potato Rot was considered in an exigency bulletin in the summer of 1889. The subject is of so much importance, that article modified and extended, is incorporated in this Report. The Apple Scab was very bad in Maine the past season. We considered this fungus in our Report for 1888, but now add (through the kindness of Prof. Galloway) the results of some experiments conducted the past season under the auspices of the U. S. Agricultural Department. We are arranging to conduct some experiments this season upon Apple Scab with the copper solutions. A paper presented by the writer at the Norway Meeting of the State Pomological Society, upon "Some Injurious Fungi of Fruits," will appear in the Report of that Society. It will in that way reach the fruit growers of the State and need not be repeated here. Of the weeds sent for examination the Rib Grass, or English Plantain, and False Flax, or Gold of Pleasure, only need special consideration.



Phytophthora infestans, De Bary.

Explanation of Plate.

This plate was used by Prof. C. H. Fernald, to illustrate an article on the Potato Rot, which appeared in the Agricultural Report of Maine, 1882, p. 210. The plate was kindly loaned by Mr. Gilbert. In using it, we are aware that the occurrence of *winter*, or *oospores* is doubted by many botanists. The writer having never seen them is not prepared to advocate either view, though analogy would strongly suggest their existence. The plate represents fairly well the mycelium, conidiophores and conidia.

1. Section of a potato leaf showing three *mycelium* threads running between the cells, and two *conidiophores* extending from them down through a breathing pore (stomate) on the under side of the leaf. One has two lateral branches with *conidia* at the ends, while on the top of the main stem is borne a conidium from which zoospores are escaping.

(The figure is wrong in representing the terminal spore as the first to mature. The young conidia are formed at the ends of the branches. The lateral are the first to mature.)

2. Conidium showing swarming spores within.

3. A zoospore much enlarged and provided with cilia.

4, 5 and 6. Represent winter spores (oospores) claimed to have been seen by Mr. W. G. Smith, but doubted by most botanists.

7. Three zoospores swimming through water.

8. Three zoospores becoming spherical and losing the cilia.

9 and 10. The zoospores germinating and producing mycelium.

THE POTATO ROT.

PHYTOPHTHORA INFESTANS, DEBARY.

(*Peronospora infestans*, *Mont.*)

The Potato Rot, Blight or Rust, as it is variously called in Maine, was very bad in this State the past season. Many letters asking information regarding the nature of this disease and its remedies, were received at the Station. To meet the case a short exigency bulletin was hastily prepared. Below we give for permanent record a fuller and better considered account of the disease and its treatment.

ORIGIN AND HISTORY.

This disease has been known in America over fifty years. It has spread to all the potato growing countries of the world, causing more damage to the Irish potato than all other diseases combined. It is common on the wild potato from which our cultivated potato was derived. The wild potatoes are supposed to have been the original source of the disease. The disease also affects the tomato. For an excellent account of the history of Potato Rot, the reader is referred to "Diseases of Field and Garden Crops," by W. G. Smith, MacMillan & Co., London, 1884.

PRIMARY CAUSES.

The *primary* cause of the Potato Rot, Blight or Rust, is a fungus parasite. It is as definite a plant as the potato, though much more simple in its structure and lower in the scale of vegetable life. It finds in the potato plant the conditions favorable for its growth and attacks it, producing the disease. It reproduces its kind, especially in the summer, by organisms called spores, which are as necessary for its continuance and extention as the seed of higher plants. The disease cannot spread except these spores are present any more than the potato can multiply without tubers.

(The disease can be produced in healthy plants by infecting them with the spores of this fungus. Plants protected from infection by the spores are exempt from the disease. This parasite is

always present in plants suffering from the Potato Rot. There are other rots, wet and dry, of various kinds, not due to *this* fungus which are sometimes confounded with it. The true Potato Rot may under different conditions be wet or dry.)

SECONDARY CAUSES.

There are several *secondary* causes which modify the disease when present. Moisture and heat favor the growth of the fungus. The disease is worse on heavy and poorly drained lands. The atmospheric conditions, the nature of the soil, the methods of culture, vitality of the plant, and the variety of the potato, have no power to originate the disease. They can only favor or impede its progress.

CONDITIONS OF GROWTH.

Warm weather and moisture at the time the summer spores are ripe and dropping, will cause them to germinate, therefore the disease is usually worse in hot, moist seasons. Should it be dry at the time the spores are ripe they soon die and the disease does not spread. The fungus seems to require a sufficient time to perfect itself before producing spores. It would produce spores earlier in early plantings and probably mature faster in early varieties. We often see early potatoes affected, while later varieties contiguous are exempt. Also early varieties exempt when later in the season the slower growing varieties alongside become diseased.

The fungus is most active when the temperature is between 60° and 70° F. At lower temperatures than 40° its developement is arrested, but it can survive a much lower degree. At 80° F and upward the spores are gradually killed. Extremely hot weather would be unfavorable to the germination of the spores. The disease does not appear in Maine until about Aug. 1st, and sometimes later, and often not before early varieties are ripe and harvested. If the source of infection is in the early potatoes when planted the disease appears earlier. If in later varieties it developes apparently later. The disease might spread from an early infected variety to a contiguous, uninfected field of later varieties, though there is reason for believing that the proper stage of developement of the potato plant is necessary for infection.

DESCRIPTION.

Mycelium.—The plant body of this fungns is composed of slender, jointless, transparent threads, which permeate the stem,

leaves and tubers of the host plant, running between the cells. The mycelium does *not* produce lateral branches (haustoria) for obtaining nourishment from the cells of the host plant.

Conidia.—The mycelium sends, during the summer months, slender branches (*conidiophores*) through the stomata or breathing pores of the under side of the leaves. The conidiophores are at first simple, but finally produce a few lateral, irregularly placed branches. They are attenuated at the apex and enlarged at the point where the conidia are located. The conidia or *summer spores* are borne on these branches. They are eliptical or oval bodies 27 to 29 micromillimetres in length, with a terminal projection at the base. The conidia are at first single at the end of the branches but finally become lateral by the outgrowth of the tip of the branch. Several spores may be produced in succession. These conidia may under proper conditions develope germ threads directly, which penetrate the breathing pores of the host, producing a new plant. More commonly the conidia produce *zoospores.* The contents of the conidia breaks up into several masses, which are finally liberated by a rupture of the wall at the small end. These minute, jelly-like (protoplasmic) bodies have the power of moving about with a jerky motion, like small animals, by means of two slender cilia or hairs attached to one side of the spore. On account of this power of motion they are called *zoospores.* The zoospores soon come to rest, lose the cilia, assume a rounded form and develope a thin membanous wall. Under favorable circumstances they send forth germ threads which penetrate the breathing pores of the potato leaves and become new plants.

Zoospores.—These are egg spores, resting spores, or winter spores as they are variously called. They are supposed to develop within the stem, leaves and tubers of the host plant and perpetuate the species. Though they are well known in related species, there is a difference of opinion regarding their occurrence in the Potato Rot.

The species has wonderful power of perpetuating itself. Some believe as winter spores in the stem, leaves and tubers; others regard the mycelium perennial in the stored tubers, and the seed the means of infection; others, (the writer belongs to that class,) do not believe the preservation of the mycelium in seed potatoes adequate to account for the continuance and spread of the disease. The writer believes there is some source of infection left behind

in the field when the potatoes are gathered. The mycelium may live over winter in potato tops and in the few tubers left in the ground.

The *zoospores* if they ever occur, may not ordinarily be produced and may not be always essential to the continuance of the disease. The known occurrence of oospores in related species, would in our estimation be stronger evidence of their existence in the Potato Rot, than the fact that they have not been seen by botanists, evidence that they do not ever occur.

Prof. Humphrey (Mass. Ex. Sta. bull. No. 6, 1889, p. 19), says: "The fungus doubtless survives the winter by the hybernation of the threads in potato tubers, but this method alone seems hardly certain enough to constitute the sole reliance of the plant."

He also says "that the existence of *winter* spores has never been satisfactorily proved."

Prof. G. W. Smith of England, claims to have found these spores in the leaves, stems and tubers, and figures them. The relatives of this fungus, the Downy Mildew of the Grape and others are known to produce winter spores, and by analogy, we would expect them to occur in the Potato Rot.

Prof. Scribner says: "The mycelium is perennial in the tubers and if these, containing this mycelial growth are used for seed, they are almost certain to carry infection to the new crop."

He does not apparently recognize any other means of survival.

We are inclined to believe that there is some means of continuing the disease in the soil after the crop is harvested. Whether this is by *resting spores* in the tops, leaves, rotten and small potatoes left on the ground, or whether the *mycelium* lives over winter in the tops and ungathered potatoes, is an open question. If the mycelium will live in the harvested potatoes we see no reason why it may not survive in the small potatoes and tops left on the ground. If potatoes left in the soil grow the next spring certainly the hardier fungus would probably survive. This matter is of fundamental importance. A definite knowledge of the winter conditions of this fungus is essential as a basis for intelligent application of preventive measures. A careful study of the possible winter conditions is of the greatest importance. It will probably be found finally that it has all the resources claimed.

Life History.

Whatever way the plant is infested, the mycelium or threads grow with it, enter the new shoots and finally penetrate the leaves.

When the plant or fungus or both have sufficiently grown, which occurs during the summer and fall months, fruiting branches are developed on the threads. These find their way through the breathing pores of the leaves, and bear the summer spores, which are developed in great numbers and blown by the wind on other plants. These spores germinate, with favorable conditions, and develope new threads, or they produce several oval shaped spores which have two vibrating hairs, by means of which they move about in water, and finally coming to rest, also produce threads. These threads enter new plants and spread the disease. The spores develope rapidly and germinate quickly, so that from a few diseased plants a large patch, under favorable conditions of moisture and heat, may be destroyed in a single day. The fruiting stalks and the mycelium from the germinating summer spores, stop the breathing pores of the plant, preventing a proper circulation. This causes rapid decay of the tissues of the plant, which turn black, becoming slimy and ill-scented. The developement of the summer spores, causes the leaves on the under side, to present a grayish mildewy appearance. Some of the summer spores fall upon the ground and are washed into the soil by rains, reach the tubers and infest them. It is supposed that the threads of the fungus go down the stems after killing the leaves, and finally reach the tubers. It is known that "potatoes covered with from 1 to 3 inches of earth are pretty certain to become diseased if the fungus is on the tops, while those planted four inches deep are more rarely infested." Prof. Scribner argues from this, that if the spores reach the tubers through the soil, those near the surface would be most affected. Would not the tubers near the surface be affected first, by mycelium descending the stem? The roots bearing them come off higher up. Are not the conditions near the surface more favorable for the rapid growth of the fungus, and possibly the infection near the surface greater from this cause? Unless the tubers are harvested before they are infected, they begin to rot in the ground, and the loss may amount to 50 per cent. of the crop. If any of the harvested potatoes contain the fungus, the disease will spread in the pits or cellar, from potato to potato. Potatoes harvested and stored damp, are likely to become infected from the germination of summer spores which fall upon them while being harvested. This completes the round of life.

For cuts and explanations see pp. 172-3.

REMEDIES.

The methods of treatment are direct and preventive. From the fact that the parasite is internal and only appears at the surface while producing summer spores, the methods must be largely preventive.

Direct Methods.

Any means by which the growth of the *summer spores* can be checked, would prevent the spread of the disease from plant to plant during the summer season, and prove beneficial.

The application of copper compounds to destroy the summer spores, has been quite extensively tried the past season at several of the Experiment Stations and elsewhere, with satisfactory results. We would recommend them for careful trial in Maine.

Solutions.

No. 1.—Mix 1 qt. of 22° ammonia water (hartshorn) with 3 ozs. of carbonate of copper. Stir rapidly until a clear liquid is produced. When ready to use it, dilute to 22 galons with water. Apply with a spraying apparatus or force pump.

No. 2.—Dissolve 2 lbs. sulphate of copper (blue stone) in hot water, dissolve and add 2 1-2 lbs. bicarbonate of soda. When cool, add 1 1-2 pints of commercial ammonia water. Dilute to 22 gallons with water. Apply as stated above.

No. 3.—Dissolve 6 lbs. copper sulphate in 16 gallons water. Shake 4 lbs. of fresh lime into 6 gallons of water. When cool mix the above solutions slowly and thoroughly and apply as stated above.

Any one of the copper compounds prepared as stated above will do, though the first two are easier prepared and applied. If 26° ammonia is used add one-third more water. Paris Green in water (1 lb. to 80 gallons) could be added and applied at the same time for the potato beetle. London purple is regarded by some as preferable to Paris Green and if used should be added 1 lb. to 100 gallons.

Remarks.

Use a force pump with brass fittings to apply these mixtures as copper compounds corrode iron. The nozzle should have a fine spray that will cover the foliage well and not drench it. The

Vermorel nozzle sold by Thos. Sommerville & Sons, Washington, D. C., price $1.50 will be found the best, if recipe No. 3 is used. The Nixon Nozzle, (Nixon Nozzle & Machine Co., Dayton, Ohio,) or any other nozzle giving a fine spray will answer the purpose, to apply the others. Make the application immediately after a rain, or when fair weather is expected. Repeat if the mixture is washed off by a hard rain. Apply about the time the disease usually appears or anticipate it, or watch the field and spray *immediately* on the *slightest appearance* of the disease.

Preventive Methods.

The following preventive measures are equally applicable, whether the theory of winter spores is adopted or rejected. The presence of the mycelium in decaying potatoes, or in the stems, leaves and tubers left in the field, would make it advisable to destroy all potato refuse.

1. Burn the tops and leaves in the fall after the crop is gathered. This is based upon the belief that winter spores are developed in the stems and leaves, or that the mycelium may possibly hybernate in them.

2. Gather all the small potatoes. As the mycelium hybernates in stored tubers, and possibly winter spores also occur in them, they would no doubt survive in potatoes left on the ground.

3. Select seed for planting, from fields or localities exempt from the disease the previous season. Great care should be exercised in selecting good seed. It is believed by some that diseased tubers are the *principal* means of infection.

4. Rotate the potato crop. This is based upon the belief that the means of infection survives the winter in the potatoes, stems and leaves left in the soil.

5. Burn all decayed potatoes taken from the cellar, or bins and all other potato refuse, do not throw them on the compost heap, as the fungus retains its vitality and is spread far and wide with the manure.

6. Plant early in the season and those varieties that mature early. This is based upon the belief that the fungus does not mature until the warm summer months, and therefore early plantings and early varieties would escape the disease from outside infection.

7. If cut seed is used, the surface should be allowed to dry, for when placed in the ground, the fungus if present, would find ready entrance to the tubers through the freshly cut surface. This is based upon the belief that the means of continuing the fungus occur in the soil.

8. If varieties less subject to the attack of the rot can be found, select them for growing.

9. Potatoes affected should be dug immediately and marketed, as the disease rapidly spreads to the tubers in the ground, and is almost sure to spread in the bin if they are stored.

10. Thoroughly dry potatoes before storing them, for, if damp, summer spores lodged upon them will germinate and develope the disease in the pit or cellar.

11. Store in a dry, cool place and keep dry, as warmth and moisture favor the growth of fungi.

12. Sort the potatoes in the cellar occasionally, and remove the infected ones, as the disease will spread from tuber to tuber.

If a dry place is not obtainable, then dust the potatoes with dry air slaked lime at the rate of one bushel of lime to twenty-five of potatoes.

14. Plant on a sandy loam, or a well drained soil, as the moisture of a heavy or poorly drained soil favor the disease.

15. Plant in narrow patches running at right angles to the prevailing summer winds. This is based on the fact that the disease usually starts from a few infected plants and the disease is spread by the wind.

16. It has been recommended to soak the tubers for 24 hours in a solution of copper sulphate, 6 ozs. dissolved in water enough to cover a bushel.

17. It has been shown that the fungus is destroyed by keeping the tubers for a few hours at a temperature of 105° to 110° F. a degree of heat that does not injure them for seed. This is a promising method, as it would thoroughly disinfect the seed a source of the disease.

18. Deep covering of seed and deep covering in cultivation have been recommended. It is believed that deep planting is unfavorable to the fungus, and that the summer spores can not reach deep covered tubers so readily.

19. Do not go through an uninfected patch after walking through an infected field, the spores will be carried on the clothing and spread the infection.

20. Do not plant early and late varieties contiguous.

APPLE SCAB.

Fusicladium dendriticum,

PLATE V.

This plate was prepared in stipple crayon after the colored plate by Geo. Marx, (Pl. II, U. S. Agr'l Report, 1887) by Miss Hannah Lord, of Orono, Me.

Fig. 1. Apple affected by the scab.

Fig. 2. Leaf of apple affected by the scab.

Fig. 3. Section through a portion of a scab spot on the fruit, showing the growth of the fungus; greatly magnified.

Fig. 4. Spores of the fungus greatly magnified; four of them germinating.

Experiments were conducted the past season with fungicides, upon the Apple Scab, in Michigan and Wisconsin by Professors Taft and Goff; under the auspices of the U. S. Dept. of Agriculture, and through the kindness of Prof. Galloway we are able to record the following results:

These gentlemen experimented with several compounds, but the copper salts were so much superior to all others, that they alone deserve consideration.

They recommend spraying just as soon as the buds begin to swell. In their experiments they sprayed seven times during the season, making the last application about Aug. 10th. In ordinary seasons our or five applications would be enough. They recommend the following:

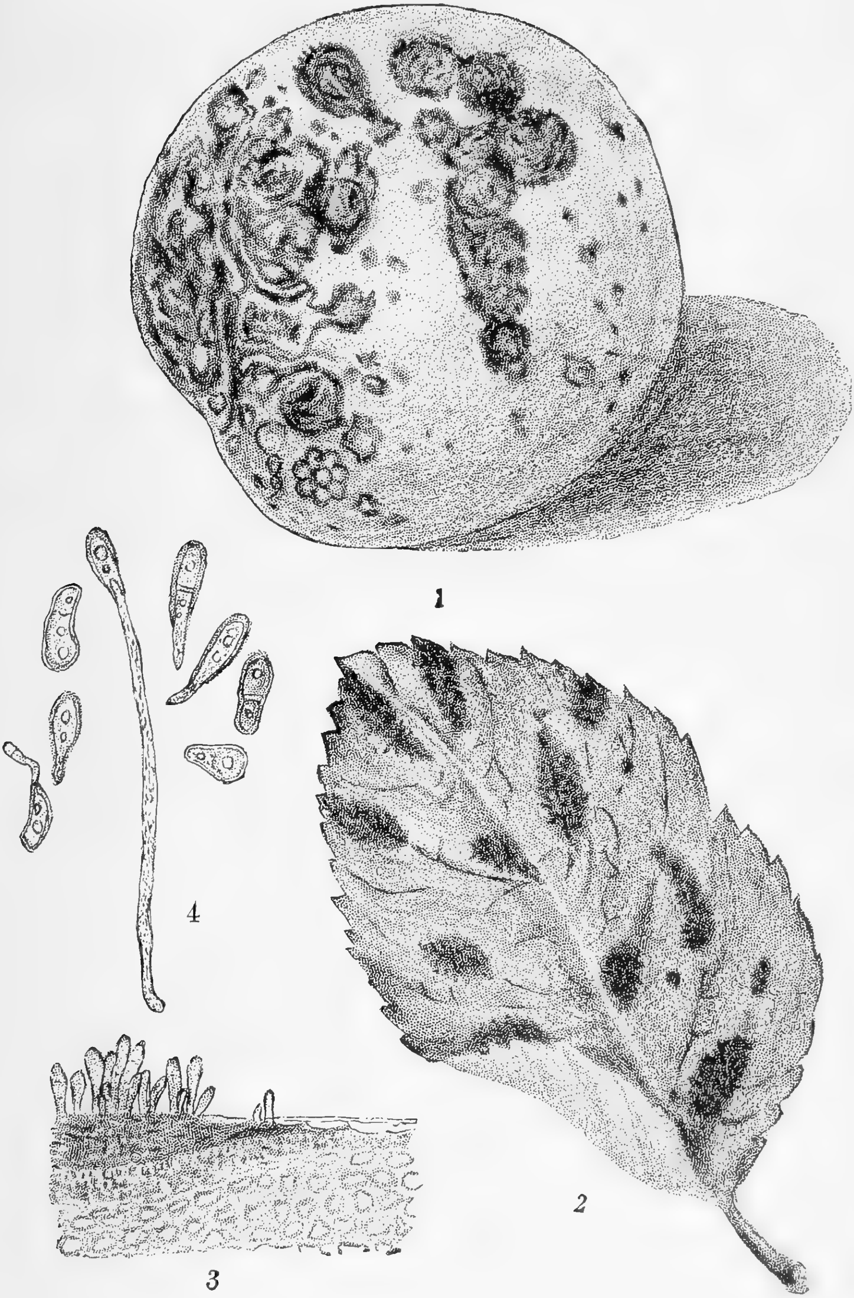
Ammoniacal Carbonate of Copper Solution.

1. Dissolve 3 ounces of carbonate of copper in 1 quart of 20° ammonia water and dilute to 32 gallons.

Modified Eau Celeste.

2. Dissolve 2 lbs. copper sulphate in hot water, and in another vessel dissolve 1 1-2 lbs. bicarbonate of soda; mix the two and when cool, add 1 1-2 pints of 20° ammonia water and before using dilute with water to 32 gallons.

PLATE V.



APPLE SCAB.

(Fusicladium dendriticum,)

After GEO. MARX, by Hannah Lord.

We give below a copy of table showing the results of these experiments:

	Professor Goff's experiments.					Professor Taft's experiments.					
	Applications.	Free from scab.	Slightly scabby.	Badly scabby.	Cost per tree.	Applications.	Free from scab.	Slightly scabby.	Badly scabby.	Cost per tree.	Total yield.
		%	%	%	cts.		%	%	%	cts.	lbs.
Potassium sulphide	7	30.04	48.55	21.41	.37	7	25.5	74.3	.2	.39	1,615¼
Sodium hyposulphite	7	43.24	42.78	13.98	.29	7	23.6	75.4	.89	.23	1,648
Sulphur powder	7	32.72	54.31	12.97	.31	6	17.6	81.2	1.1	.31	1,435¼
Am'l copper carbonate	7	75.02	23.35	1.63	.38	7	51.2	48.6	.16	.49	2,112¾
Eau celeste	..	.....	.....	.....	....	7	68.8	31.0	.2	.60	1,675½
Sulphur solution	3	4[illegible].9	48.99	8.11	....	..	....	....	....	....	......
Unsprayed	..	23.34	53.89	22.71	....	..	12.5	85.7	1.8	....	769¼

"*Results.*—The copper solutions remained persistently on the leaves, even resisting heavy showers, which washed off all traces of the sulphur compounds, and when the leaves fell in October traces of copper could still be see on them."

"At time of harvesting Professor Taft picked all the apples on the trees and assorted them into three lots, of first, second, and third quality. The first class contained those free from scab, the second those slightly scabby but not distorted or under size, the third those that were distorted or under size. Those in each class were counted and the percentage which they formed of the whole estimated.

"At Ithaca, Wis., the apples were not all picked, but a market-basket holding about 1½ pecks was first filled with apples from the lowest branches of one of the trees. Next a similar basketful was picked from the branches that were just the height one could conveniently reach, taking care to pass clear around the trees in both cases. After this a basket of one-half a bushel was filled from the tallest branches of the tree. The apples were then poured upon an assorting table; and the baskets filled and emptied again in the same manner and from the same tree, after which the contents of the six basketfuls were assorted into three qualities as in the preceeding case."

"It is evident from the tables that the sprayed trees, especially those sprayed by copper compounds, producing a much larger percentage of healthy fruit than the unsprayed. The greatest difference between the perfect fruit on sprayed and unsprayed trees under Prof. Goff's charge was 51.68 per cent. and the least 6.7

per cent. The greatest difference in those under Professor Taft's charge is 56.3 per cent. and the least 5.1 per cent., the two results being essentially the same.

Besides the tabulated results there were others which are of great importance but can not be estimated in exact figures. A scabby apple is much smaller than a healthy one, and in many cases, while the apples could not be placed in class one, the scab had so been held in check that the fruit had obtained a greater size than it otherwise would. Professor Taft gives the difference in weight between perfect and scabby fruits as varying from .037 to .002 pound for each apple, and says the scabby apples are 10 per cent. smaller than the perfect ones, making a difference of nearly a bushel per tree in size alone, besides the fact that the apples that are badly scabby are unmarketable. "From the combined effect of the two causes," he says "we lost on some trees a barrel of apples."

"The cost of the chemicals and labor expended varied but slightly in the two cases, but both gentlemen were obliged to buy chemicals in small amounts, and the cost per tree would be greatly lessened by treating a large orchard and buying materials in quantity. Professor Taft used large trees requiring three gallons each for each application, while Professor Goff used three gallons for the two trees, but Professor Goff estimates the labor higher than Professor Taft, and this makes the figures nearly alike. Both these estimates, however, are for seven applications. In an average season, and with the copper solutions, four or at most five applications will probably be sufficient. It is likely that in a large orchard with average sized trees, when the chemicals were purchased by the quantity the expense could be reduced nearly one-half. The expense of the ammoniacal solution in particular would be reduced by purchasing the copper carbonate instead of preparing it from the sulphate."

In Mr. Goff's calculations the cost for labor in making the treatments amounts to more than half the expense.

It seems probable that it would be profitabe to make the first application earlier than was done this year, and there is no reason why this application, or the next should not be combined with London Purple, or some other insecticide, and the tree protected from insects and fungi at the same time. Mr. Hatch closes his report thus:

"What we now need is to determine the correct amount of the copper mixture to use, the times best suited to its application, and what combinations to make with insecticides, and a new era in fruit culture will be inaugurated."

FALSE FLAX, OR GOLD OF PLEASURE.

Camelina sativa, (Crantz.)

This weed may be known by the following description: Pod pear shaped, pointed, swollen, flattish parallel to the broad partition that divides the pod into two cells; valves with one nerve. Seeds numerous, oblong and some larger than a flax-seed. Flower, small, yellow. The plant is an annual, has lance shaped, or arrow shaped leaves and a large margined pod. Introduced from Europe where, it is used somewhat for the oil contained in the seeds, known as Oil of Pleasure. The stem yields a fibre sometimes used for making sacks, rough paper and brooms. We call attention to this weed as it has appeared in the State and though perhaps not so bad as the black mustard, yet it belongs to the same family and has the same habits and if allowed to spread will add one more annoyance to the farmer. Below we copy a letter, regarding this weed that appeared in the *Maine Farmer*, which may be interesting:

Mr. Gilbert, Dear Sir:—I enclose a weed taken from a field of oats on the farm of Lincoln Sprague in South Presque Isle. The field consists of about two acres sown with oats raised by himself. One-half of the piece was sown with a quantity of Bradley's superphosphate. On the half sown with the phosphate the oats are full of the weed, while on the other half the weed is not to be found. It is a new weed in this section. Please tell me the name of the weed? I would like to know at the same time if foul seed is one of the ingredients used in manufacturing superphosphate? Yours very respectfully,

PRESQUE ISLE, July 27.

H. H. COOK.

[Will Prof. Harvey examine and report to *Maine Farmer*?]

Z. A. GILBERT.

Z. A. Gilbert, Dear Sir:—The weed which you enclose for determination belongs to the mustard family (Cruciferae) and is known to botanists as *Camelina sativa*, Crantz. The common name is False Flax or Gold of Pleasure. The name Wild Flax is in allusion to the fact that it is a weed in flax fields and was supposed by the ignorant to be degenerate flax. The plant has been

grown for the seeds, which yield an oil superior to rape seed oil for burning. The stems also yield a coarse fibre which is suitable for sacks, brooms and rough packing paper. The plant is a native of France, introduced with seed to this country, where it has gained only the reputation of a detestable weed. The plant seeds profusely, and a few scattering plants allowed to go to seed would the next season produce an abundant harvest. The best way to get rid of it is careful cultivation in some hoed crop. The plant being an *annual* would be exterminated if not allowed to seed. It does not seem possible that the seed could have been introduced in Bradley's phosphate as suggested by Mr. Cook. He could satisfy himself on this point perhaps by noticing whether the weed occurs in other fields where Bradley's phosphate was used. It is more probable that a few seeds were introduced last season from some source, and the plants escaped notice, and seeding so abundantly have apparently come suddenly the present season. Their being confined to one side of the field may be explained readily by supposing that the plants which produced the seed for this season's crop grew upon that side of the piece, and that became a centre of distribution, which happened to be the same ground on which the phosphate was used. We should like to know the history of the field, upon which the weed grew, for the last three years, and whether the weed is found elsewhere. Look especially about the railroads, as they bring many weeds in ballast and upon freight, and even the cars themselves transport seeds which the winds have blown upon them. The packing material thrown out by merchants is often the source of introduction of vile weeds. A phosphate might introduce into a field the seed of a weed which had accidentally got into it during transportation, but it would be unjust to hold the phosphate responsible.

Orono, Me., Aug. 2nd, 1889.

F. L. HARVEY,

Botanist for the Station.

RIB GRASS, OR ENGLISH PLANTAIN.

Plantago lanceolata, L.

This weed belongs to the Order *Plantaginaceae* (Plantain Family) and may be known by the following description:

Root living from year to year; stem grooved, angular, nine inches to two feet high; leaves hairy, narrow, three to five ribbed and in a cluster at the root. The flowers small, whitish, borne in a thick short spike at the end of the long flower scape. The pod opens at the top by means of a lid and allows the two oblong boat shaped seeds to escape. These seeds are smaller than clover seed and may be distinguished by the brownish color, oblong shape and hollow or groove on the inner face. They look like a diminutive boat. Attention is especially directed to this weed, as it is being introduced into the State in clover seed. Complaints have been received of fields over run with it, that were seeded to clover. The seeds of the plantain being smaller and duller colored are liable to escape notice, being hidden by the bright yellow color of the clover seed. Great care should be exercised by farmers in purchasing clover seed, so as not to introduce this detestable weed. We hear complaints of its occurrence in other States. Being a perennial it is a hard weed to exterminate. It is hardy and will cover the ground with a mat of leaves. Cultivation in a hoed crop would be the best way to control it.

Accompanying this Report is an envelope containing New York Red Clover seed, adulterated with about ten per cent. of Rib Grass seed, (*Plantago lanceolata, L.*) This seed was purchased at a prominent seed store in Maine and was highly recommended. We distribute the material that farmers may learn to distinguish the seed of Rib Grass and avoid it.

INJURIOUS INSECTS.

The past season has been remarkable for the injurious insects that appeared in unusual numbers.

Forest Tent Caterpillar.

The Forest Tent Caterpillar was especially abundant in the forest along the Canadian Pacific in the vicinity of Sebois, where it occurred in such great numbers on the railroad track as to grease the rails and impede the movement of trains. It fed principally on the poplar, but when its favorite food was wanting, repasted upon the foliage of the Oak, Cherry, Maple, Willows, Elm, Gray Birch and other trees. In the Penobscot Valley it was unusually plentiful, causing much annoyance and considerable damage to orchard and shade trees. They transformed in abundance and many eggs were laid and unless they meet with mishaps the pest will be plentiful in 1890. (History shows that they are not abundant many years in succession, as parasites increase and check them.) Crushing with the hand, burning with a torch, and applications of kerosine or strong soap suds to the caterpillars when in bunches, were the methods resorted to to destroy them. This winter some have carefully removed from the apple trees, all the clusters of eggs they could find.

The Codling Moth.

The Codling Moth did much more damage apparently than usual. Probably the insect was no more abundant, but it being a shy bearing year the effect was more noticeable.

When the trees set much fruit, some of our orchardists regard the Codling Moth a blessing, as they do the proper thinning. The apples affected by the first brood all drop, and in a good year enough are usually left. The greatest damage is done by the second brood. The caterpillars have insufficient time to mature before cold weather checks their work, but they have so far progressed that the calyx of the apple is badly eaten. The worms are not large enough to transform and probably many of the second brood in Maine perish. The work of the second brood in Maine does not affect the core, only a portion around the calyx being damaged. The apples are blemished, which injures them

for market. This season three-fourths of the apples from some sections showed the work of the second brood Codling Moth.

Answers to questions sent out by the State Pomological Society to Fruit Growers, indicate that from 10 per cent. to 50 per cent. of the apple crop in Maine is damaged by this insect. We regard it the most injurious insect to the apple in the State. Though when not too abundant it may prevent over bearing, yet it would seem that it has already far exceeded its sphere of usefulness in that direction and should at least be checked. It can easily be managed by spraying with Paris Green, or London Purple, and there is no reason why orchardists should suffer from its ravages. Especially should the matter receive attention when the trees show light bloom and a short crop is inevitable. The subject of spraying and spraying apparatus is considered elsewhere in this Report.

Various other Insects.

The Fall Canker Worm and the White Marked Tussock Moth were reported from several localities and appear to have been much more abundant than usual. They were feeding on the foliage of apple trees. The May Beetle was reported as doing much damage to grass lands in some parts of the State. The above insects will be considered more fully at some future time.

THE APPLE MAGGOT.

Trypeta pomonella, Walsh.

Order Diptera, Family Trypetidae.

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Riley.—Amer. Agric., July 1872, V. 31, pp. 263-264, 2 figs; N. Y. Semi-Weekly Tribune, 15 Dec., 1876; Amer. Ent., July 1880 (V. 3) N. S., V. 1, pp. 159-160; Stoddard's Encyclopædia Americana, 1883, V. 1, p. 135.

(*a*) Comparative descriptions and figures of larvæ, pupa and imagos of *Trypeta pomonella* and Carpocapsa pomonella; figures showing injuries of both species; distribution and means against Trypeta.

(*b*) Description larvœ, pupa imago; ravages, food plants, habits, means against, literature.

(*c*) Example of acquisition of new habits in insects.

Cook.—Rept. Mich. Bd. Agric. 1889, p. 152; Rept. Mich. Expt. Station 1889, p. 97, (attacks plums and late cherries in Michigan.)

Cordley—Orchard and Garden, 1889, Vol. 11, No. 10, p. 192, (records occurrence in plums and cherries in Mich.)

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1882.—p. 101, Extracts from Prof. Comstock's paper in U. S. Agr'l. Rept., 1882, p. 195. Supplementary remarks to above by S. C. Harlow.

1883.—p. 30, Hon. Robt. H. Gardner; p. 43, T. S. McLellan; p. 61, Hon. Z. A. Gilbert.

1884.—p. 70, L. H. Blossom.

1887.—p. 9, Remarks by the Secretary D. H. Knowlton; pp. 84-85, Prof. Carl Braun; p. 101, P. M. Augur.

1888.—p. 26, Pres. Chas. S. Pope; p. 56, Prof. Maynard; p. 114, Questions to fruit growers by Sec'y. Knowlton; p. 117, remarks by Committee on Lists of Fruit.

The above Transactions also occur in the Maine State Agr'l. Reports of the corresponding years.

History and Distribution.

Both the fly and the maggot of this species appear to have been observed many years before Walsh published his original description in the American Journal of Horticulture, December 1867. Walsh states that he bred the flies from maggots found

in wild haws, (thorn apples or thorn plums, as they are variously called,) five or six years before his description appeared. The flies and maggots were known in the Eastern States several years before 1867, and at that date their ravages upon cultivated apples claimed serious attention in New York, Massachusetts, Connecticut and Vermont. To Walsh belongs the credit of showing, that the maggots affecting cultivated apples were the same as those he found in haws; and that the beautiful fly known in the cabinets of Eastern Entomologists, was an undescribed American species of Trypeta and the perfect form of the Apple Maggot.

Prof. Cook records its occurence in wild haws in Michigan, Illinois and Wisconsin. Prof. Comstock bred it from a species of haw (*Cratægus*) growing upon the agricultural grounds at Washington. We find no reference to its having been found elsewhere in haws. We have not found it in haws in Maine. The published statements regarding its universal distribution in haws are not based on *observation.* There are no positive observations of its feeding upon wild crab apples, (Pyrus). Walsh says it feeds "*probably* upon our native crabs." Comstock and Lintner write me they did not record its occurrence in crab apples from personal observations. The wild crab apples are hard during the time the flies are on the wing and would not appear to us to be a proper nidus for the maggot. The writer lived twenty years in the Mississippi valley where crab apples are common and did not see Trypeta. Prof. Cook has not found it in crab apples but writes us that Trypeta has been found the past season (1889) in Michigan infesting plums and late cherries. In considering the history and distribution of this insect outside of Maine, we can do no better than take extracts from Walsh, Comstock, Lintner and Cook.

In 1866 Walsh had knowledge of its occurrence in Massachusetts, Connecticut, New York and probably Vermont.

In New York it was prevalent at the Oneida community; North Hempstead, L. I. and occured generally through the Hudson river country. In Massachusetts at East Falmouth. Its occurrence in Vermont in 1867 is uncertain. In July 1867 Walsh bred the flies from maggots received from Connecticut, Massachusetts and New York.

Comstock in 1881 records its occurrence in New Hampshire, where, according to Mr. N. W. Hardy, it had infested the early varieties in the towns of Hancock and Dublin for the last six

years. He had personally observed it for several seasons in one of the orchards of Cornell University, N. Y., infesting a few varieties.

Lintner writes in 1885: "The most serious account of its injuries have been received from Vermont. In New Hampshire in a few localities it has ruined entire orchards, (Rept. Comm. Agr'l. for 1881, p. 190.") * * * "Mr. L. L. Whitman writes from North Auburndale, Mass., I had hundreds of bushels of the finest fruit rendered worthless by the apple maggot last year." "From Franklin, Delaware County, N. Y., larvae have been reported." Personally Prof. Lintner captured the flies occasionally at Schenectady, N. Y., from the 3d to the 27th. of July.

Prof. Cook in 1884 writes: "Last year I received specimens from Delavan County, Wisconsin, with the information that it was doing great damage. This year the enemy has attacked us on our own ground. I know from personal observation that in Michigan in Ingham and adjoining counties it has wrought considerable mischief."

The following predictions made by Walsh in 1867 are almost prophetic. "There can be but little doubt that the descendants of the improved and highly civilized apple maggots in the East will, in processs of time and by slow degrees, spread gradually to the West, or they may be suddenly introduced in a barrel of Eastern apples into some point at the West, and thence radiate in all directions and colonize the country."

We find no mention of its occurrence in Maine in any publication outside of the State. In the State it is referred to in the Agricultural and Pomological Society Reports, in newspaper accounts and in a recent Bulletin issued by the Expt. Station at Orono.

The pest was undoubtedly introduced in Maine in early fruit shipped from adjoining States. Mr. T. S. McLellan, (Me. State Pom. Soc'y Rept., 1883, p. 43) says: "Some five or six years since, I noticed that the earliest sweet apples we received from the South were infested with a minute worm, which had thoroughly perforated the fruit. Three years since, I noticed my earliest sweet apples were similarly affected, and last season all my sweet apples and most of my pleasant tart apples, such as the Haley, Hurlbut, Nodhead, Primate and Porter were more or less infested." Our observations confirm this as we have the past

season found early apples, shipped from Boston and exposed in the Orono and Bangor markets, literally alive with Trypeta larvæ.

Mr. McLellan also refers to its occurence in the northern part of Somerset County at that time.

Mr. Harlow (Me. St. Pom. Sec'y Rept. 1882, p. 104) says: "This insect seems to have increased to such an extent in our State within a few years as to cause serious alarm among fruit growers." The above would indicate that the pest was, in 1882, well established in Maine.

Mr. S. R. Sweetser, of Cumberland Centre writes: That in August 1880 he first noticed the flies on King Sweets and the same season the larvæ were found in Talman's Sweets.

Mr. D. H. Knowlton, (Me. State Pom. Soc'y Rept. 1887, p. 9) says: "In some parts of York, Cumberland, Sagadahoc, Kennebec and Androscoggin counties the insect has already become a great pest and its increase may well be regarded with alarm."

Mr. Augur, (Me. State Pom. Soc'y Rept., 1887, p. 101,) says: "We have been exceedingly troubled with the apple maggot; so much so that it has broken our confidence in some varieties, so that we have hardly dared to sell them, we have found them so generally affected."

Mr. Sweetser, who has been much annoyed by this pest, writes: "That his apple crop was poor this season(1889,)and badly affected with maggots. That his neighbors, who have not been troubled with the fly much before, complain that their apples are badly affected this year." Reports from many places show that the pest has done much damage in the State this season.

Mr. Chas. S. Pope, (Me. Pom. Society Report 1888, p. 26,) says: "This troublesome insect is now found in several counties in the State and is doing much damage to fruit. The insect seems to work mostly in fruit grown in sheltered places, around buildings, or in places otherwise protected from the cold winds. So far as our observation extends they are not working very much in the orchards of the State, except as noted above."

Mr. D. H Knowlton, (Me. Pom. Rept. 1888, p. 117,) says: "Its ravages, though extending over a large part of the State, seem to be confined mainly to sheltered areas and have not yet generally injured the fruit grown in the larger orchards."

The observations of the writer so far as they go confirm the above statements.

The writer has examined many varieties of apples during

the past two seasons from various parts of the State and his observations show that the pest is on the increase, becoming gradually more widely distributed, doing greater damage where it occurs and constantly extending its depredations to new varieties and new orchards.

Through correspondence, personal observation, the examination of many varieties of fruit from many localities of the State, and through questions sent to fruit growers by the St. Pom. Soc., we glean, that the pest does the most damage in the western part of the State, and is widely distributed in Oxford, Lincoln, Somerset, Franklin, Androscoggin, Kennebec, Cumberland, Knox, Waldo, Sagadahoc and York counties.

The writer has found it in the Penobscot Valley at Stillwater, Veazie and Bangor, and the towns of Charleston and Corinth, in Penobscot County and at Bucksport in Hancock County. In the answers to the Pom. Soc. questions it is reported from forty-four localities in the State. We have no knowledge of its occurrence in Piscataquis and Washington counties.

Mr. W. P. Gerrard, of Caribou, Me., writes us that apples from Plymouth, Levant, Garland, Corinth and Dexter and other towns in Penobscot County, sold in Aroostook, are often badly bored by maggots, but he has not seen it in Aroostook grown apples.

Introduction.

Since the introduction of the Apple Maggot in Maine, eight or ten years ago, it has done enough damage each year to attract the attention of fruit growers. It has been considered in the Reports of the State Pomological Society almost every year for the last eight. Accounts of its ravages have frequently appeared in the public prints. During the last four years the writer has received many letters regarding it.

Its ravages have gradually increased. Each year it has extended its depredations further, until it is now nearly State wide in its distribution. It has gradually spread from variety to variety until a large per cent. of the varieties of apples grown in Maine are known to be affected by it.

Its distribution is so wide and its annual depredations so great, that it seriously threatens the fruit interests of the State and therefore, a consideration of its life history is a matter of State importance.

When the Experiment Station was organized two years ago, and an Entomologist appointed, it was decided to make a careful study of this insect.

To thoroughly investigate an insect the first step necessary is to make out its complete life history. With a knowledge of its life changes the weak points are made known and advantage can be taken of them in devising methods to hold it in check or destroy it.

Knowing that prominent Entomologists who had written about *Trypeta pomonella*, differed much upon several points in its life history; and also aware that its eggs and egg laying habits were *entirely* unknown; plans were laid to carry out a series of careful observations, embracing a study of the whole life of the insect and an investigation of the subject so far as possible in all of its bearings.

It became apparent at once from the nature of what had been written, that it would be impossible to glean the true from the false, and therefore hazardous to accept any statement, however noted the authority, without a careful verification.

During the last two years, under the most favorable circumstances, we have carefully reviewed all the published statements, accepting such as were verified and rejecting what appeared untenable.

The material at our command has been ample. Hundreds of infested apples of many varieties have been inspected. Maggots by the thousand; hundreds of pupæ; thousands of eggs, taken from the apples and from the ovaries of the females; and over two hundred flies, bred or captured about the trees, have been examined. From these examinations we have found reason to correct many statements, confirm others and add much that is new, especially about the eggs and reproduction of this insect.

We have been materially helped in our investigations by the aid and encouragement of others. In fact, without the assistance so cheerfully given by many, our work would have been impossible. We desire especially to thank Mr. Chas. S. Pope, Mr. J. W. True, Hon. Z. A. Gilbert, Mr. D. H. Knowlton and Mr. S. R. Sweetser, members of the Pomological Society, for specimens sent, observations made and kind encouragement in the work. We are greatly obligated to Mr. L. H. Merrill, of the Experiment Station for photographic work, to Profs. Riley, Comstock, Lintner and Cook for answering questions, loaning literature or aiding in

the bibliography of this insect, and to Prof. Riley for use of cuts. Prof. Jordan has taken a personal interest in following the researches. By his liberal policy the work has been advanced and this report so fully illustrated. Many points, not of especial economic importance, but of zoological consequence, have been incorporated in this Report, it being the present policy of this Station to record in its Bulletins all the results of research, both technical and practical.

We feel gratified that circumstances have enabled us to make these important investigations. It cannot be hoped that the work is entirely free from error, but an endeavor has been made to faithfully record what the eyes have seen. The cuts illustrating this Report, so far as they are original, were made by the writer, or photographed from microscopic preparations made by him, and may be regarded, as to outlines, reasonably correct. The drawings of the male and female flies were modified from Prof. Comstock's cut in the U. S. Dept. of Agr. Rept., 1881-2. We have also included *unchanged* from the same plate the excellent figures of the pupa, jaw system, cephalic and caudal spiracles, and a plate illustrating Pomace Flies.

The work is humbly submitted as a contribution to the life history of this insect, with the hope that it may aid somewhat in an intelligent struggle with this serious pest.

Sketch of Work, 1888-9.

The investigation was commenced under great difficulties. The way had to be felt step by step. At the time we began work Trypeta was unknown to us about Orono. The complaints were mostly from the Western part of the State. The material for study had to be sent by mail or express from the infested district.

Work began July 5th, 1888 upon the Benoni, a sub acid, early autumn variety. The apples at that date were about three-fourths of an inch in diameter. Observations were continued that season until Nov. 6th. Though this variety was regarded by some as an unlucky choice, and that an early sweet apple would have been better, yet the results show it served the purpose well. We selected this variety because it was badly affected in 1887, and because it was an autumn variety and would enable us to continue the investigation later in the season. Though this variety was made the basis of regular observations many other varieties were incidentally examined.

Fifty-two lots of apples, embracing several hundred specimens of many varieties, were regularly examined in 1888. These studies referred largely to the maggots, pupæ and the flies. In 1889 an investigation of the eggs and the egg laying habits was carried on in the labaratory and field.

We spent a week in Cumberland County in July 1889, studying the flies and their egg laying habits. Observations were made and recorded upon the following points:

(a) Larvae: First appearance in fruit; time required to mature; date of first maturity; conditions affecting rate of growth; time they remain in fruit after it is mature; time they first leave the fruit; nature of exit; time the larvæ remain in late fruits; first and latest pupæ formed; where the larvæ spend the winter; number of larvæ in a single fruit; presence of larvæ in hanging fruit, marketed fruit, windfalls; presence of larvæ in imported fruit; varieties affected, number and kinds; distribution in the State.

(b) Pupæ: Depth they go into the ground to transform; their occurrence in decayed fruit, on the surface of the ground, about grass roots and in apple barrels and bins; time required to transform; will they transform uncovered in dry jars under ordinary conditions? will they transform in bins and barrels kept in damp cellars? will earlier pupæ transform earlier in the spring? the time late pupæ transform.

(c) Flies: Number of broods; time of appearance in confinement and in nature; time they are on the wing in nature; relative number of males and females; feeding habits; time of life; copulation; nature of the ovipositor; method of laying eggs; puncture made by ovipositor; nature of internal reproductive system of female; male genitalia; what depth of earth will prevent the flies from transforming.

(d) Eggs: Number laid; time of laying; method of laying; position in the fruit; distribution in the fruit; development in the ovaries of the female; relation of Codling Moth to Trypeta work.

The larvæ, pupæ and flies were carefully compared with published descriptions and corrections made. For microscopical examination many slides were mounted, of the eggs, abdomens of females and males, the ovipositor, male genitalia, wings of the flies, feeding apparatus of the larvæ, the larvæ entire, and por-

tions of the apple peel showing larvæ exit holes and the punctures of the ovipositor.

To illustrate this Report photographs and measurement drawings were made. From the photographs some outlines were obtained for pen and crayon stipple drawings. These drawings are found in their proper places. Methods of capturing the flies, and also experiments with insecticides were tried. Incidentally the presence of other apple insects was recorded.

Work in Progress.

We are still at work upon the following questions: Will early formed pupæ transform earlier in the spring? Early and late maggots have been allowed to transform and the time the flies emerge will be noted. What depth of earth will prevent the flies appearing? Pupæ have been put at various depths in sand and the greatest depth from which they emerge will be recorded. Will pupæe found in barrels and bins in cellars transform? Pupæ, uncovered with earth, have been placed in open vessels and will be examined for flies.

TABULATED RECORD OF WORK, 1888.

Number.	Apples examined.	Variety.	Locality.	From whom obtained.	Date examined. mo.	Date examined. day	Trypeta entrance holes.	Trypeta larvae seen.	Size of Trypeta larva in fraction of inches.	Trypeta with Codling Moth.	Codling Moth.	Plum weavel punctures.	Effective plum weavel punctures.	Ash Gray Pinion.	Miscellaneous unknown.	Perfect fruit.	Affected fruit.	Remarks.
1	9	Benoni	Manchester	Charles S. Pope	7	5						6	3	2	1	4	5	Fruit ¾ inch.
2	12	"	"	"	7	9						2				10	2	
3	12	"	"	"	7	14						4	2			10	2	Egg of plum weavel found, oval, white .07 in. x .043 in.
4	10	"	"	"	7	17						2	2			8	2	Egg found.
5	12	"	"	"	7	24						1	1	1		10	2	
6	5	Greening	New Gloucester	W. H. Jordan	7	30						8	3			2	3	
7	5	Nod-head	"	"	7	30					2	13	11		1	1	4	Badly affected, four plum weavel larvae and a codling moth in same fruit.
8	6	King of Tompkins	"	"	7	30					1	13	9		2	2	4	
9	6	New York Sweeting	"	"	7	30					4	4	4			1	5	Three codling moths in one fruit.
10	6	Gravenstein	"	"	7	30						14	10	1			6	Badly affected.
11	6	Early Harvest	"	"	7	30					5	2	1	2		2	4	Codling moths, 1 stem and 2 blow end.
12	5	Baldwins	"	"	7	30					2	6	2			2	3	Codling moth larva full grown.
13	6	Cat-head	"	"	7	30					1	11	6		2	1	5	Two plum weavel larvae dead.
14	6	Bellflower	"	"	7	30					2	6	2			2	4	
15	6	Benoni	"	J. W. True	7	30						7	7	2			6	Windfalls.
16	8	"	"	"	7	30						11	3			1	7	From tree.
17	6	Franklin Sweet	North Greene	Z. A. Gilbert	8	2					3					3	3	
18	11	Benoni	New Gloucester	J. W. True	8	6	4	4	.03					2		5	6	First trypeta larva found.
19	6	"	Manchester	Charles S. Pope	8	10					3	16						Codling moth left fruit.
20	12	"	New Gloucester	J. W. True	8	14	48	5	.06 to .1	1	4						12	The most of this lot laid aside to transform.
21	6	Red Astracan	Manchester	Charles S. Pope	8	18					3	10	2			2	4	Codling moth full growm, two in one apple, one in cheek.
22	11	Benoni	New Gloucester	J. W. True	8	21	125	7	.11			2					11	Trypeta punctures mostly on pale cheek.

23	4	Franklin Sweet	Manchester	Charles S. Pope	8	23	9	2	.08		2						4	
24	3	Tetofsky	Farmington	D. H. Knowlton	8	24	Many	2	.25	1	2	1	1	1			3	First full grown Trypeta.
25	12	Red Astracan	Manchester	Charles S. Pope	8	28	"	17	.25	1	1					2	10	Entrance holes numerous. Three Trypeta larva in one fruit.
26	6	King Sweet	"	"	8	31	"	21	.25								6	Exit holes first observed. Seven Trypeta in one fruit.
27	6	Fameuse	"	"	8	31	15	10	.08 to .15								6	
28	6	Munson Sweet	"	"	8	31	80	14	.25								6	Two of these laid aside to transform.
29	7	Diana	"	"	8	31	67	20	.13 to .25	5	5						7	Exit holes of Trypeta.
30	6	Summer Sweet	"	"	9	6	15	7	.03 to .13	3	3						6	Larvae just hatched 1-16, ¼, ½, grown.
31	20	Benoni, (windfalls)	New Gloucester	J. W. True	9	12	Many	25	.25	2	2						20	Pupa found in fruit. 10 apples with exit holes and no larvae. 9 pupae in the box.
32	10	Benoni, (trees)	"	"	9	6	"	19	.25									6 in one fruit, one larva, one half grown.
33	23	Benoni, (trees)	"	"	9	20	"	52									23	This lot laid aside Sept. 6th. 52 pupae in box Sept. 20th, and fruit not greatly changed.
34	12	Red Astracan	"	"	9	7		1	.25		1	6					7	Entrance punctures in only one.
35	5	N. Y. Sweets	"	"	9	7	"	16									5	These all showed exit holes.
36	6	Sops of Wine	"	"	9	7	"	3	.13								3	
37	2	Sweet Unknown	Oxford Co., S. Fair Exh't	D. H. Knowlton	9	15	"	5	.06 to .25								2	Larvae 1-4, 1-2, and full grown.
38	1	Unknown Tart	" "	"	9	15	"	2	.25								1	
39	1	Red Striped Sweet Unknown	Lincoln County	"	9	15	"	3	.13								1	
40	1	King Sweet	"	"	9	15	"	1	.13								1	
41	2	N. Y. Sweet	"	"	9	15	"	4	.08								2	
42	2	Unknown	S. Androscoggin	"	9	15	"	2	.08								2	
43	1	N. Y. Sweet	Kennebec County	"	9	15	"	1	.06								1	
44	2	Unknown Red Tart	"	"	9	15		3	.16								2	
45	1	Red Astracan	"	"	9	15	"	8	.13 to .25								1	One-half and full grown.
46	1	King Sweet	"	"	9	15	"	3	.25								1	
47	1	Early Harvest	Franklin County	"	9	15		0								1		
48	2	Winthrop Greening	"	"	9	15	"	8	.08									Badly rail-roaded. Two dead larvae. Surface riddled with punctures.
49	1	Fameuse	"	"	9	15	"	1	.06									
50	2	Early Harvest	Cumberland County	"	9	15	"	3	.08									
51	2	King Sweet	" "	"	9	15	"	4	.25									
52	6	High T. Sweeting	Manchester	Charles S. Pope	11	6	"	4	.16		1							Codlin moth only one-half grown, probably second brood.

DISCUSSION OF OBSERVATIONS.

LARVÆ.

How Do the Maggots Enter the Fruit.

Early in 1888 we noticed small punctures through the skin of apples and found they led to minute channels in the flesh. By carefully following these channels we found the larvæ of Trypeta. We also worked the other way, found the very young larvæ in the flesh, traced their route backward and in several instances was able to follow it to these characteristic openings. These openings were found to be distributed over all parts of the fruit; blossom and stem ends, and cheeks, but more abundantly on the cheeks, and more frequently on the pale or shaded side of the apples. All the flies observed ovipositing were in the shade at the time the eggs were laid. This is natural, as the skin on the shaded side would be softer. In highly colored apples these punctures are hard to detect. In light colored apples they can be plainly seen with the naked eye. They are not readily detected, except by practice, from the brownish rust spots naturally found on fruit. This is probably why they have not been before observed.

How Long Does It Take the Larvæ to Mature.

In 1888, in Benonies, we found maggots one-eighth grown (Aug. 6th.) They could not have been hatched more than a week or so, as they were so small and the channels short and near the surface. By the 14th they were found one-fourth grown. By the 21st they were one-half grown. By Sept. 12th they were found in abundance full grown, and had commenced to vacate the fruit. The above observations were made upon apples taken from the same tree.

In 1889, in Early Harvests, the minute larvæ but a short time hatched were observed about the 10th of July. The maggots left the fruit and entered the pupæ state by Aug. 10th. From the above, we conclude that under *favorable circumstances* they mature in from four to six weeks, and soon leave the fruit. Observations on several other lots in 1888-9 confirm the above conclusions.

Arrested Development of Larvæ.

In the fall of 1888 a lot of apples which had been on exhibit at the State Fair was received for examination. Though it was the middle of September, the larvæ were small and many of them dead. We learned that some of the apples had been kept in cold storage and all in cool places. We suspected arrested development. We had come to believe from the examination of many apples, that somehow the maturity of the larvæ and the ripening of the variety were somewhat coincident. Had noticed that the larvæ grow much faster as the fruit softens. To test the effect of cold storage, a *portion* of a lot of Early Harvests collected July 9th, 1889, were placed in an ordinary ice chest. The remainder of the same lot was kept in a box under ordinary conditions. They were first inspected August 10th, and the larvæ from those kept under ordinary conditions had emerged, and the pupæ were found in the box. None had emerged from those in the ice chest. Those in cold storage were cut and examined from time to time, the last being opened September 15th, and the larvæ were still in them.

In 1888 we found larvæ half grown November 6th. In 1889 Mr. Briggs found a half grown larva December 1st. We found one December 25th, half grown, in a King Tompkins. Mr. R. S. Sweetser showed a larva at the Pomological Society meeting at Norway, Febuary 4th, and sent the writer larvæ about February 15th. If the eggs in these cases were laid at the time of killing frosts, October 10th, then the eggs remained unhatched longer than the usual time, or the larvæ in some cases are from two to five months reaching maturity. Cold seems to check development. The larvæ grow faster as the fruit softens. May not the occurrence of Trypeta larvæ in late winter fruit be from eggs laid late in the fall, which from cold are tardily hatched and from the effects of cold and the hard ttssue of winter apples are a long time in reaching maturity? May not cold storage arrest the work of Trypeta larvæ in fruit and prevent its rapid deterioration?

Are Trypeta Larvæ Found in Windfalls?

The examination of numerous specimens taken from the ground has shown conclusively that the maggots are found abundantly in windfalls. We have never seen exit holes in apples hanging on the trees and believe that the maggots remain in the fruit until it drops or is gathered. The presence of the maggots seems to hasten the maturity and dropping of the fruit. Larvæ are found abundantly

in marketed fruit from Massachusetts, which shows, that the larvæ will remain a long time after the fruit is harvested. Any very young larvæ will remain in the decaying apples until they are a mass of corruption. We received a lot of windfalls from Mr. True, shipped about September 6th. They were not examined until September 12, when in twenty of them we found twenty-five full grown maggots and several pupæ in the box. Hanging fruit picked from the same tree at the same date was full of younger maggots. From twenty-three specimens put in a box, fifty-two pupæ had emerged by September 20th. This shows that the apples having the older larvæ matured and dropped earlier.

When do the Larvæ Begin to Leave the Fruit?

The larvæ begin to mature about the first of August, in the early varieties and soon leave the fruit and enter the pupæ state. They may be found of all ages, in the summer and early fall varieties during the summer and fall, and emerge when mature. The larvæ hatched from eggs laid late in the season may be stored with the fruit and emerge any time during the winter, or remain sometimes by arrested development in the fruit until February. Maggots may vacate fruit when the food supply is abundant and it is occupied by younger larvæ of several ages. They leave the fruit through circular openings a little larger than the maggot. Several of these are sometimes found in the same fruit.

Transformation of Larvæ.

In 1888, August 8th, we found the first Trypeta larva about one-third grown in Benonies and laid some of the apples aside in a box over sand and left the larvæ to enter the ground. From time to time through August, September and October we laid others aside, but did not keep the lots separate, not then thinking that the early larvæ might transform earlier in the spring. The jars and boxes were kept in a room where there was a fire most of the time and where it did not freeze. The sand was somewhat moist when put in the boxes but as gauze was put over them the moisture soon evaporated so the sand was practically dry. About the first of May we moistened the sand in some of the jars and left it dry in others. Two or three lots of pupæ were left in jars and not covered with sand but not one fly came from these. In 1889, August 10th, we put some pupæ in a box without sand and examined them December 1st and all were dead. One box was

examined to see how deep the larvæ had burrowed to transform, and fourteen pupæ were found from one-half to one inch below the surface in loose sand. One or two were noticed to transform at the surface under decayed fruit. A few were also found in the shriveled fruit in the pupæ state. The flies began to emerge first from the jars which had been moistened. Below is a record of the time of appearance of the flies.

Date.	No.	Wet sand.	Dry sand.	Date.	No.	Wet sand.	Dry sand.
May 23....	2	+		June 25	3		+
June 4....	1	+		" 27	3	+	
" 7....	3	+		" 27	1		+
" 15....	4	+		July 4	2		+
" 19....	2	+		" 4	2	+	
" 20....	2		+	" 5	1		+
" 22..	5	+		" 7	2		+

The time of emergence covered about six weeks. The flies were at once transferred to a large box with a glass top in which fresh apple leaves were kept and apples with fresh cut surface. Some syrup made from white sugar was put in occasionally and they ate of it greedily. The flies appeared very quiet and often remained for a long time in the same place on a leaf, the side of the cage or upon the cut surface of the fruit. None of them lived over three weeks. None were noticed copulating.

Where do the Larvæ go to Transform?

The depth to which they go in the ground to transform was determined by putting infested apples in boxes over loose sand, and examining later for the pupæ. Our observations confirm those of Comstock and Cook, that, under the most favorable circumstances, they do not burrow over an inch. The larvæ, being footless and weak, have but little power to penetrate hard soil, and hence find the most favorable places for development in sandy locations. In orchards kept in sod, they do not find favorable circumstances for burrowing and undoubtedly enter the pupa state about the grass roots and are subjected to more mishaps. Even when they have loose sand to burrow in, they do not always enter the ground, as we have found pupæ on the surface of sand under decayed fruit. They are sometimes found in the fruit in the pupæ form during the summer months, and quite frequently in stored fruit. If infested fruit is left in a box, barrel or bin, the most of the larvæ will leave the frnit, and the pupæ will be found in the bottom of the receptacle.

Mr. Sweetser sent us a lot of Spitzenbergs and Hubbardstons in

December, 1889, and we found many exit holes, a few pupæ and occasionally a larva. We asked Mr. Sweetser to examine the barrels in which the apples were stored, and he sent us eighty pupæ.

Mr. Henry S. Smith of Monmouth, Me., says: "I swept up and burned large quantities of pupæ from where I stored Nodheads and Tolmans on the cellar floor. The apples had been in barrels until put up for market in December and January."

We have had a great many larvæ leave the apples and enter the pupa state in the bottom of the boxes and jars containing them.

Egg-Laying Habits of the Fly.

When do the flies lay their eggs?—The published views on this point are, that the eggs are not laid until late summer or mid-autumn. Comstock says: "According to my observations and all published accounts, the apple maggot does not occur in the apple until the latter part of the summer. "Lintner says: "During the latter part of the month (July) or in August it deposits several of its eggs upon an apple near the calyx end." Perkins says: "As the maggots do not eat the apples until well advanced toward maturity it is obvious that the eggs are not deposited on the fruit until the end of summer, and from that time to mid-autumn." Our observations do not warrant the above conclusions. The eggs begin to be laid in Maine, on the earlier varieties, by July 1st, and probably earlier in the states farther south. Oviposition continues until the flies die in the fall by killing frosts. We found numerous small Trypeta larvæ in Sweet Boughs and Early Harvests by July 9th. Comparing their size with newly hatched larvæ they must have been a few days old. Allowing for the time required to hatch it would make the time of egg laying July 1st or earlier. Larvæ found in early imported fruit from Massachusetts were more mature than in the above, which would mean earlier egg laying in Massachusetts.

They are found in abundance in half grown apples. The channels made by the *young* larvæ are largely healed by the growing tissue and might lead to the view that "they do not eat the apples until well advanced toward maturity." They are there, nevertheless, ready to rapidly grow when the pulp softens. As the fruit matures, the channels no longer heal, and being larger, become apparent. The close observer will find plenty of larvæ before the large yellow channels made by the adult can be seen. We had pupæ in considerable numbers the last season by August 10th. The fact that maggots of all sizes can be found from early in July until cold

weather shows that oviposition continues through the season. This is confirmed by an examination of females taken about the middle of September. In them were found plenty of mature eggs and others in varying stages of development.

EGGS AND REPRODUCTIVE SYSTEM.

Discovery of the eggs in the apple, and also in the ovary of the female, completes our knowledge of the life changes of Trypeta. The researches of 1888 made us familiar with the entrance punctures. These were again found in the first lot of apples examined early in July, 1889. The first puncture examined contained one egg inserted vertically beneath the skin, and entirely concealed in yellowish, withered tissue. It was described and figured. The second apple revealed another egg, which was photographed. A third egg was transferred to a live box in apple juice and watched. In about fifteen minutes a motion was observed in the end opposite the pedicil. Soon the shell burst irregularly, the head of the larva protruded, and in less than a minute it had crawled out. A careful examination under high power proved it to be the larva of Trypeta. We went to Cumberland Centre the next day to study the insect at home. Caught several pairs copulating, and made a careful microscopical examination of the reproductive system. Found eggs in great numbers, which agreed exactly with those found in the apples During the season hundreds of eggs were taken from the females and many temporary and a few permanent slides prepared and additional photographs made. We believe no one will dispute our claim to discovery of the eggs, as nothing has heretofore been written about them.

NATURE OF THE REPRODUCTIVE SYSTEM.

We find no record of a histological examination of this part of the insect. The oviduct leading into the ovipositor is short and soon divides into two quite long convoluted tubes, one on each side, leading to the ovate ovaries, which nearly fill the abdominal cavity. Each half ovary contains about twenty-four chains of eggs, each chain having at least seven eggs attached together, in different stages of development, which would make the number of eggs at least 336. As many as eleven stages in the development of the eggs were observed. As many as seven stages were frequently seen attached and we are not prepared to say but what the loose forms seen in the reproductive passages were also detached

parts of the chains, which would increase the number of eggs to 528. Nor are we prepared to say but what the pear-shaped unsegmented body at the other end of the chain might develop still others. See Pl. II, Figs. 4-10. We actually counted forty-eight chains in several insects and each chain had at least seven eggs, which would make 336 eggs as the minimum number. The chains of eggs were mounted and drawn to scale and are shown (Plate II, Figures 4-10.) The developmental stages of the eggs show conclusively that oviposition is necessarily extended over considerable time.

Discovery of the Ovipositor as a sharp instrument, fully capable of making a puncture through the skin of an apple, is a very important observation. The ovipositor has been described as truncate and blunt by Loew, Lintner and Perkins and incapable of making a puncture. All references to the ovipositor we have seen undoubtedly refer to the last abdominal segment, the ovipositor and sheath retracted within it apparently never having been seen. The ovipositor is shown (Plate II, Figures 1 and 3) to be a sharp instrument fully capable of making an incision. Out of over fifty flies only a few died with the ovipositor extended, and in cabinet specimens it is usually retracted within the sheath. We have several slides showing the ovipositor extended, also cabinet specimens showing it finely. Some may claim this discovery for Walsh, as he says the insect oviposits through the skin of the apple, but he examined apparently only one female, and we doubt his having seen the ovipositor. Most eminent Entomologists since Walsh have doubted the insertion of the egg, never having described or figured the ovipositor, therefore, credit should be given to the one who first describes and figures the instrument and observes it do its work.

Confirmation of Walsh's statement, that *the female punctures the apple to lay her eggs* is exceedingly interesting, for as Prof. Riley writes us, "It is opposed to everything which we know regarding the egg laying habits of *Diptera*." This has been denied by all prominent Entomologists since Walsh's time. By witnessing the oviposition; finding the eggs in the characteristic punctures; observing one hatch and proving it to be Trypeta, and by finding the same eggs in the ovary of the female that we found inserted beneath the skin of apples, the position of Walsh is sustained. By means of a jeweler's glass on the eye we witnessed the process of oviposition several times. The fly would run about over the apple nervously for a short time as though selecting a suitable place, then coming to rest, elevated the thorax behind and turned the abdomen

nearly at right angles to the thorax. The legs were spread out as though to brace the insect. The sharp, brownish ovipositor was then plainly protruded, and by repeated vertical motions inserted into the apple. So far as we could see, the ovipositor pierced the skin the first plunge and the continued probing was to enlarge the hole. We could not see the egg escape, as the opening to the oviduct was concealed below the skin of the apple. The process occupied a half minute or so. In all the cases we observed, the insect oviposited in the shade. The puncture cannot be easily seen at first, but soon the adjacent tissue changes to brown and shrivels, showing the opening plainly with a brownish areola around it. We marked around one puncture as soon as it was made and examined it five days later, finding the shell of the deserted egg and in a channel close by leading to it the young larva.

Relation of Trypeta to Other Insects.

The published views on this question are: (*a*) That the eggs are deposited directly in holes made by other insects; (*b*) That they are deposited on the surface of the apple near the calyx end, the hatched larvæ entering the holes made by other insects, especially those of the codling moth; (*c*) There is an implied view expressed by Prof. Perkins that they are deposited on the outside, hatch there, and the young larvæ early bore through the peel and enter the fruit. Hundreds of apples have been found infested by Trypeta with no evidence of codling moth work or the work of any other insects, and no external openings, excepting the small punctures made by the Trypeta fly. The finding of Trypeta eggs beneath the peel of apples in these characteristic punctures, settles the question beyond dispute, and warrants the conclusion that *the work of Trypeta is entirely independent of other insects.* This is important, for there was a hope that the destruction of the codling moth would check this pest by destroying its means of entering the fruit.

Insects Sometimes Mistaken for Trypeta.

The term *apple worm* is often vaguely applied to any sort of larva infesting the apple. The name *apple maggot* is frequently incorrectly given to the true apple worm, the caterpillar of the codling moth. While in some parts of the country the true apple maggot, the larva of Trypeta pomonella, is called the "*railroad worm.*" The larva of the codling moth is usually in Maine

correctly called the apple worm, but sometimes it is confounded with the apple maggot. The term maggot is restricted by Entomologists to footless larvæ of two-winged flies. The larvæ of the codling moth have legs and spin cocoons and are correctly called caterpillars.

There should be no trouble in distinguishing the apple maggot and its work, from the codling moth and its injuries. The apple maggot or "railroad worm" tunnels the pulp of the fruit, filling it with brownish channels, while the codling moth caterpillar usually enters the calyx, works about the core and finally leaves the fruit through a direct channel from the core to the cheek.

Apple worms spin cocoons, which are placed under the loose bark of trees or elsewhere *above ground* and from which moths ("millers") come forth. Apple maggots go into the ground to spend the winter and from their pupæ two-winged flies, (described below) and related to the house fly, mosquitoes, and crane flies, come forth. The apple worm is larger and has sixteen legs, a broad black head with a black patch behind it, and is usually pinkish in color. The apple maggot is smaller, footless, tapering to a small head, and greenish white or slightly yellowish in color.

The apple maggot deposits its eggs in the fruit while on the trees and is found in the hanging, stored and marketed fruit, and in the windfalls. In apple pomace and decayed fruits, other maggots are frequently found in great numbers. These are generally the larvæ of *pomace flies*, which work in apple and other fruit refuse and do no injury. We have never seen or heard of *Trypeta flies* laying their eggs in apple refuse, and any worms found in such material may be considered as the larvæ of other insects. These pomace flies are plentiful in Maine about decaying apples, apple pomace, crushed fruit, vinegar barrels and apple driers, and are often a nuisance. We took three species of pomace flies about apple trees in Cumberland county early in July, the two species considered by Prof. Comstock (U. S. Agr'l Rept., 1881–2, p. 198) and another undetermined species. The flies are smaller than Trypeta, light brown or yellowish, and have clear wings and red eyes. The pupæ and maggots are smaller and more slender than those of Trypeta. The maggots change to the pupa state within or about the decaying fruit. We have taken more than a hundred pupæ from a single decayed apple, and from a single apple have bred nearly a hundred of the vine-loving pomace flies. Their time of

transformation is short. Many broods appear in a season. That the pomace flies may be readily distinguished, we give (Plate IV) a copy of Mrs. A. B. Comstock's excellent drawings, taken from United States Agricultural Report, 1881–2, Plate XVI. For a more detailed account of the pomace flies the reader is referred to the above named Report, p. 198.

Varieties Known to be Affected by Trypeta Pomonella.

Variety.	Flavor.			Time of Maturity.	Remarks.
	Sweet.	Sub-acid.	Acid.		
Alexander			+	Autumn	Sparingly infested.
American Golden Russett				Winter	" "
Bailey Sweet	+			"	" "
Baldwin			+	"	" "
Benoni		+		Autumn	Badly "
Canada Baldwin			+	Winter	Sparingly "
Cat-head		+		Autumn	" "
Colvert		+		"	" "
Danver's W. Sweet	+			Winter	" "
Derby Pippin		+		"	" "
Diana		+		Autumn	" "
Duchess of Oldenburgh			+	"	" "
Early Harvest		+		"	Badly "
Esopus Spitzenburgh		+		Winter	" "
Fall Jenneting		+		Autumn	" "
Fall Pippin		+		"	Sparingly "
Fameuse		+		Winter	" "
Franklin Sweet	+			Autumn	Badly "
Garden Royal		+		"	" "
Golden Ball		+		Winter	Sparingly "
Golden Russett		+		"	" "
Golden Sweet	+			Autumn	" "
Gravenstein		+		"	Badly "
Greening R. I.			+	Winter	Sparingly "
Grime's Gold Pippin		+		"	" "
Haley		+			" "
High Topped Sweeting	+			Autumn	Badly "
Hubbardston None-such		+		Winter	Sparingly "
Hurlbut		+		Autumn	Badly "
Irish Peach		+		"	Sparingly "
King Sweet	+			Summer	Badly "
King Tompkins Co.		+		Winter	Sparingly "
Lady's Sweet	+			"	" "
Maiden Blush	+			Autumn	" "
Mexico	+			"	" "
Mother		+		Winter	Badly "
Munson's Sweet	+			Summer	" "
New York Sweet	+			"	" "

VARIETIES KNOWN TO BE AFFECTED BY TRYPETA POMONELLA.
(*Continued.*)

Variety.	Flavor. Sweet.	Sub-acid.	Acid.	Time of Maturity.	Remarks.	
Nodheads		+		Winter	Badly	infested.
Northern Spy		+		"	"	"
Paradise Sweet	+			"	"	"
Pearmain		+		"	"	"
Penankee		+		"	Sparingly	"
Porter		+		Autumn	Badly	"
Pound Sweet	+			Winter	Sparingly	"
Primate		+		Summer	"	"
Pumpkin Sweet	+			Autumn	Badly	"
Ramsdell's Sweet	+			Winter	Sparingly	"
Red Astrachan		+		Summer	Badly	"
Ribston Pippin			+	Winter	Sparingly	"
Rolfe		+		"	"	"
Russell		+			Badly	"
Sherwood's Favorite		+		Autumn	"	"
Snow		+		"	"	"
Somerset		+		"	Sparingly	"
Sops of Wine		+		Summer	Badly	"
Sweet, or Yellow Bough	+			"	"	"
Tetofsky	+			"	"	"
Tallman Sweet	+			Winter	"	"
Twenty Ounce		+		Autumn		
Wagner		+		Winter		
Wealthy		+		"	"	"
Westfield's Seek-no-further		+		"		
William's Favorite		+		Summer	"	"
Winthrop Greening			+	Autumn	"	"
Yellow Bellflower		+		Winter	"	"

REMARKS.

No pains have been taken to make an exhaustive list of apples affected by *Trypeta*, but in pursuance of work upon this insect, the writer has found it in most of the varieties named. The list has been extended by several members of the Pomological Society. Probably other varieties grown in the State are infested. The list is full enough to convince any one that Trypeta works in a wide range of varieties, and is not fastidious, but gratifies sweet, sub-acid and acid tastes and indulges in summer, autumn and winter fruits. Varieties sparingly or not at all affected in some parts of the State are badly infested in other places. In the table, the terms sparingly or badly infested, refer to the writer's knowledge of the frequency of Trypeta in the State and will of course not be correct for any given locality.

Spread of Trypeta from Variety to Variety.

Trypeta has been in the orchard of Hon. Samuel Libby, of Orono for the last three years at least, but has confined its depredations to a single Benoni tree. They are not scarce on that tree as the writer has taken as many as three larvæ from a single apple. Within twenty-five feet is a Wealthy, fifty feet a Red Astrachan and sixty feet a Nodhead, all varieties badly infested in other other orchards in the State, but not a single maggot has been detected in any of them.

The same is true in Mr. Webster's orchard on the other side of the river, where Trypeta has for several years feasted on Golden Russetts while several other varieties equally inviting have been exempt. Last season the Golden Russett did not bear and the fly transferred its depredations to another variety near by. Within 100 rods of Mr. Webster's orchard, across the river from it, is another orchard where early sweet and sub-acid varieties are grown, yet Trypeta has not been detected.

Mr. Atkins says: "That in Bucksport some trees of a variety will be infested while other trees of the same variety in the same orchard are exempt."

The slowness with which this pest spreads from tree to tree, and variety to variety in an orchard, and from orchard to orchard, has been noticed by Comstock and others, and when any attempt has been made to explain it, it has been by saying the insect is *fastidious* in its tastes. It is probably true, taking the whole State or country, that the pest is worse upon summer sweet and sub-acid varieties, but it does not confine itself to these. The long list of varieties we publish, which are infested, shows a wide range of occurrence in sweet, sub-acid and acid, summer, autumn and winter fruits. The history of this insect in Maine shows that it was first introduced from adjoining states in early imported fruit. It has gradually spread from the early varieties until neither sweet, acid, sub-acid, early or late apples are exempt from its attacks.

The larvæ from early apples enter the pupa state earlier and emerge earlier in the spring, or from the earlier apples there would be generated an early race of flies. These would appear under ordinary circumstances when the early apples were ready to receive the eggs, and before other varieties were far enough advanced, and the early apples would continue to be infested from year to

year. If the early apples did not bear, or from arrested or accelerated development the flies appeared earlier or later than their accustomed variety, they would be forced to find a new nidus for their eggs. Let us suppose this to be a later variety; then, as this variety matures later, the larvæ would enter the pupa state later, and appear the following spring a later race of flies. Our observations show that the flies are on the wing from early July until frosts; that the flies continue to emerge for a long time, or that there are several races of flies appearing at different times. A mild winter might force the late pupæ and convert them again into an early race, which will explain the disappearance of larvæ from a later variety and their appearance in an earlier variety.

In some orchards the flies appear later and affect the later varieties worse than the earlier. This may be because the later fruits were first affected and the flies have continued in them, or the location of the trees or the nature of the soil may give unfavorable conditions for early development. The above facts illustrate the erratic habits and wonderful adaptability of Trypeta, and must impress us with the fact that we have a formidable pest with which to contend.

We believe that each tree usually produces the flies that infest it. The flies were thick early in July on Early Harvests, but at that time none were found about the trees of later varieties. Later in the season the fruits of the fall and winter varieties became infested. The Trypeta fly is not adventurous, does not roam about to gratify the requirements of a fastidious appetite, nor does it stay so closely at home because it is over particular about what it eats. It is rather easily pleased, contented with what is set before it, be it *wild haws or Early Harvests.* It clings from year to year to the variety chance has thrown in its way, and does not abandon it, until by over-increase or want of bearing, it is forced to find another nidus for its eggs.

In Illinois though common in wild haws it has not until recently spread to cultivated fruit. It probably left the haws in the East because in the settlement of the country the wild haws were cut. In Michigan it has been forced to infest wild plums and cherries. These things do not show fastidiousness but adaptability in a wonderful degree. Certainly an insect contented in wild haws would revel in any kind of a cultivated apple. The fact that the pest has spread in our orchards slowly to apples of all flavors and times of maturity shows an alarming power of adaptation to new food

and surroundings. It shows that if deprived of the softer and earlier varieties it is still equal to the emergency. Adaptable, contented, the perfect embodiment of the sentiment "be it ever so humble there is no place like home."

General Description.

Perfect insect a two-winged fly somewhat smaller than the house-fly. Readily recognized by its general black color; yellowish head and legs; dark feet; greenish, prominent eyes; white spot on the back and upper part of the thorax; three white bands across the abdomen of the male and four across the abdomen of the female, and four black bands across the wings, resembling the outlines of a turkey. (See plate I, figures 1 and 2.)

Technical Description.

Perfect insect (female)—Maximum length, 6.2 mm. (.245 in.); minimum length, 5 mm. (.205 in.); average length of ten specimens, 5.8 mm. (.228 in.) Maximum spread of wing, 12.5 mm. (.5 in.); minimum, 10.8 mm. (.43 in); average of five, 12.15 mm. (48 in.)

Head—Light brown or pale rusty red; space between the eyes in front and the antennæ, darker; front of the face and hind orbit of the eye more or less tinged with white, the latter bearing a row of black bristles; antennæ, .5 mm. long; (.02 in.) three jointed; the first joint shortest; second joint having numerous short, thick, black bristles on the inner face; third joint as long as the other two, oblong, rounded at the end, flattened on the inner face, pubescent. Arista, dark brown, slender, more than twice the length of the joint; frontal bristles black. Mouth large, broader than long; palpi and proboscis pale yellow and pubescent. Eyes prominent, length 1 mm. to 1.25 mm. (.04 in to .05 in); breadth .45 to .50 mm. (.018 in. to .02 in.); green with reddish brown, greenish and steel blue reflections in life, but dull and greenish black in cabinet specimens.

Thorax—Maximum length 2.75 mm. (.11 in.); minimum length 2.25 mm. (.09 in.) Black. A white stripe on each side in front of the wing, involving its base and the humeral callosity. Thoracic dorsum with four narrow silvery or bluish gray longitudinal stripes arranged in pairs. The pairs separated by a median, broad, black space. Stripes of each

pair separated behind by a narrow, black line, confluent in front, the inner stripes shorter. Scutellum, elevated, flat, white above with black sides and base. Bristles of the thorax and scutellum black. Balancers three jointed, outer joint black, prominent, irregularly triangular, basal joints brownish.

Abdomen a little longer than broad. Length, 2.22 to 2.3 mm. (.088 to .092 in.) without the ovipositor. Black, ovate, composed of seven segments. First and second segments rapidly widening. Second segment widest. Sixth segment abruptly narrowed, shorter than the fifth, and apparently rudimentary and represented below only by a narrow sternite. Seventh segment truncate at the end, when the sheath and ovipositor are retracted, but sloping into the sheath when it is protruded. Posterior portion of the second, third, fourth and fifth segments (occasionally the sixth) broadly banded with white.

Ovipositor—Length, 1.33 mm. (.053 in.); breadth .33 mm. (.0133 in.) at the middle where it enters the sheath, broadest at the base, tapering from where it leaves the sheath to a sharp point somewhat curved (usually upward) at the end. (See Plate II, Figure 1.) Brownish, hornlike, bearing a median groove below, which is covered by two flaps which extend half way from the sheath to the point. These flaps are covered by a shorter median one. From beneath the flaps the eggs escape. In specimens mounted in balsam the oviduct and ovipositor show within the sheath to its base.

Sheath of the ovipositor .67 mm. by .233 mm. (027 in. by .009 in.); oblong, largest at the base, then narrowing, widening again in the middle, narrowing again and at the lower end widening into a terminal ring. Truncate at the end. Beautifully marked above and below by oblong tubercles arranged in about fifteen oblique rows, beginning at the base of the sheath and sloping backward each way from the median line above and below. The rows from above and below meet each way on the sides at an angle. A triangular space on the sides at the base and above not tuberculate. The tubercles become smaller and less conspicuous toward the sides. (See Plate II, Figure 1)

Legs about 3.75 mm. long (.15 in.) Femora and tibiæ about equal, 1.5 mm. (.06 in.) Tarsi shorter, .75 mm. (.03 in.) Femora black with yellowish distal and proximal ends. Front pair lighter, with hind sides more or less dark. Proximal joints of all the tarsi and tibiæ clay yellow. Distal joints of tarsi *all* clothed with dark

hairs, making the feet *all* more or less black. (See Plate I, Figures 1, 2 and 3.)

Wing—4.5 mm. to 5.5 mm. long (.18 in. to 22 in.,) 2 mm. to 2.5 mm. (.08 in. to .1 in.) broad, hyaline, traversed by four black cross bands. Base of the wing clear; first band beginning opposite the sinus of the basal lobe, sloping backward and joining the second band about the middle of the posterior margin. Second, third and fourth bands confluent in front and diverging backwards. The dark bands are arranged so as to resemble the outlines of a turkey, the band toward the body representing the neck and head, the second the body, the third the legs and the fourth the tail. The whole surface of the wing covered with minute hairs, those on the bands black, the others clear. Margin of the wing all around and the subcostal vein armed with bristles. (See Plate I, Figures 1-2.)

Perfect insect (*male*)—Same general color as the female but smaller; length 4 to 5 mm. (.16 to .2 in.); five instead of seven segments to the abdomen, second, third and fourth segments *only* banded with white. Wings shorter and narrower and not spreading so much behind when the fly is at rest; abdomen of the same general shape but smaller. (See Plate I, Figure 2.) Copulatory apparatus 3 mm. (.12 in.) long, yellowish brown; the penis coiled and with the auxiliary organs usually folded under the abdomen in a broadly oval cavity which extends forward to the middle of the fourth segment. The genitalia are shown Plate II, Figure 2. (*Notes.*—The eyes are sometimes variegated with brownish and greenish patches. The fifth abdominal segment is occasionally narrowly banded with white. Sometimes the white abdominal stripes in places involve the whole width of the segment. The coloring at the angle of meeting of the first and second proximal bands in the wings is quite variable, from hyaline through faint, dusky shades to black. The black bands are quite variable in brightness. They seem to be brighter in the males.)

Eggs—Length (.8 to .9 mm.,) (.032 to .036 in.); breadth (.2 to .25 mm) (.008 to .009 in.); white in the oviducts, but light yellow when taken from the fruit; fusiform and about four times as long as wide; pedicelate at the end; pedicel about one-twentieth of the length of the egg, longer than broad and rounded at the end; pedicelate end broadest and abruptly sloping into the pedicel; other end more sloping. The shell of the egg at the pedi-

celate end, for one-fourth of the length, is pitted with irregular hexagonal cells, the borders of which are raised and lacerated, giving a roughened or spinose appearance to the surface ; sculpture most prominent near the pedicel and gradually lost in the general surface which is smooth ; the spinose portion is darker. The larva is placed in the egg with the head away from the pedicel and the end containing the head is inserted into the apple. Ovaries double and saccate, occupying most of the abdominal cavity ; each side containing twenty-four chains of eggs, each chain at least seven eggs in different stages of development. Perfect eggs and stages of development are shown on Plate II, Figures 4-9.

Larva—Length, 7 to 8 mm. (.28 to .32 in.) ; breadth, 1.75 to 2 mm. (.07 to .08 in.) When full grown usually yellowish white. When younger and sometimes when full grown tinged with greenish ; footless ; the body composed of fourteen segments. Ninth, tenth and eleventh segments widest, narrowing rapidly toward the head, which is small, pointed and emarginate. From the broadest segment the body slopes slowly backward to the last segment, which maintains its size one-third of its length, and then abruptly slopes to one-half its thickness. The lower and posterior half is nearly vertical behind, giving the larva a docked appearance. (See Plate I, Figure 3.) From the lower part of the first segment are protruded a pair of black, curved, parallel hooks, the *rasping organs*, by means of which the maggot tunnels the fruit. These hooks are attached to a black chitinous framework (see Plate III, Figures 1a and 1b), the crest of which shows plainly from above through the first three anterior segments and gives the impression of a black spot back of the head. To the unaided eye the hooks and chitinous framework appear as two small black spots headward. When the first three segments are retracted the head appears somewhat blunt, and the hooks do not show. On the dorsal surface on each side, at the union of the third and fourth segments, are two yellowish brown tubercles, the anterior openings of the breathing organs and called the *cephalic spiracles.* (See Plate III, 1a and 1b.) These tubercles can be seen by the unaided eye, but their structure cannot be determined. When magnified, they appear funnel-shaped with the border of the funnel expanded into a double row of about twenty cylindrical projections. At the base of the funnel is a short bulbous enlarge-

ment. Leading backward from each spiracle to the last segment of the body is a tube or air passage (trachea) which terminates on the sloping surface of the last segment, in a caudal spiracle. One of the caudal spiracles enlarged is shown Plate III, Figure 1c. At the junction of the fourth and fifth segments, and the junction of the next to the last and last segments, are branch tubes connecting the tracheæ.

Pupa—Length 4.2 to 5.2 mm. (.17 to .21 in.); breadth 2 to 2.6 mm. (.08 to .1 in.). Pale yellowish brown. When the maggot assumes the pupa state it does not shed the larval skin. The maggot contracts, assuming an oval form. The head segments are entirely retracted so that the tubercles of the cephalic spiracles project in front. The posterior end contracts but the caudal spiracles remain in view and the larval segments are easily made out. The true pupa is found within this shrunken larval skin, or in the language of the Entomologist the pupa is *coarctate*. The pupa is a little more than twice as long as wide and barrel shaped, the ends sloping about equally. The larva is about four times as long as wide and the head end is very sloping and pointed. The pupa is only twice as long as wide and nearly equally sloping at the ends. Otherwise the resemblance between the pupa and larva is apparent. There is quite a variation in the size of pupæ, some are much longer and thicker than others and may be of females, as the female flies are much larger than the males. (See Plate III, Figure 2.)

Life History.

In early seasons, under favorable conditions, the flies in Maine begin to emerge about July 1st, and earlier in the States farther South. They continue to emerge all summer and are on the wing in abundance until the middle or last of September and occasionally in October. Early frosts check them. The flies lived three weeks in confinement and will probably live longer in nature. They begin to deposit their eggs in the early fruit by July 1st or earlier, and egg laying continues while the flies are on the wing. The earlier races of flies affecting the earlier varieties, and the later races the fall and winter fruit. Each female is capable of laying, at least, between three and four hundred eggs, which are inserted from time to time, one in a place, by means of a sharp ovipositor through the skin of the apple. The eggs being successively developed in the ovary of

the female, after the manner of the eggs of the barn-yard fowl, the season of egg laying extends over considerable time. The eggs are vertically inserted into the pulp of the apple, with the end opposite the pedicel, which contains the head of the maggot, pointing toward the core. The eggs are deposited in all parts of the apple, usually upon the cheeks, sparingly near the calyx and stem ends, and more abundantly upon the pale or shaded side of the fruit. The time required to deposit the eggs is about one-half minute. By means of the sharp ovipositor a characteristic puncture, .33 mm. (.0133 in.) diameter, is made through the skin of the apple. These punctures can be detected by careful observations with the naked eye, but a pocket lens is necessary to see them well. They appear as brownish specks, and have not been before distinguished from the brownish, rusty spots common on apples. Under the glass they appear as circular or oblong openings, surrounded by a brownish border, somewhat shrunken by the shriveling of the tissue beneath. They may be numerous on the same apple. The eggs hatch in four or five days under favorable conditions and the minute larvæ begin at once to work in the pulp of the apple. They have no true opposable jaws, but the head is provided with two black curved hooks, situated above the mouth, with which they rasp the pulp of the fruit rapidly by means of a vertical movement of the head. They live upon the juice of the particles of apple thus detached which is sucked into the mouth. The pulp is rejected and turns brown. They can burrow their length in soft fruit in less than a minute. The channels made by the young larvæ, while the fruit is still growing, are largely healed and neither they nor the minute white larvæ are liable to be detected by the naked eye or by the casual observer. As the larvæ grow and the fruit matures, the enlarged channels do not heal, but turn brown and the presence of the maggots is then readily detected. These channels meander through the whole fruit even the core. They often cross each other, enlarge as the larvæ grow, and in the last stages of Trypeta work run together, producing large cavities. Finally they involve the whole fruit, rendering it a worthless mass of disgusting corruption, held together by the peel.

In the early stages of Trypeta work there is no external evidence that the fruit is infested, excepting the punctures made for the insertion of the eggs. By these punctures the presence of the maggots can be detected. In advanced Trypeta work, brownish trails, where the larvæ have come to the surface, can be seen

through the skin. Apples marketed with no suspicion of their being infested are frequently found hopelessly involved, honey-combed, and worthless. Apples apparently sound when gathered, may by the presence of eggs or young larvæ, afterwards become hopelessly involved. The newly hatched larvæ are a little shorter than the egg and could not be readily detected in the white pulp of the apple without a pocket lens. They attain their growth, under favorable circumstances, in four or five weeks, but their development may be arrested by cold, insufficient food, hardness of the fruit, &c., for a great length of time. They remain ordinarily in the fruit but a short time after they are mature. They often leave it and go into the pupa state when there is an abundance of nourishment and the fruit is still occupied by younger larvæ of various ages. If the fruit is kept cold, though full grown, the larvæ remain longer or may even change to the pupa state within it. We have never see the exit holes in hanging fruit and believe the maggots do not drop, but go into the ground from the fallen fruit. Their presence causes the fruit to mature earlier. Fruit picked from the trees may contain larvæ and often stored or marketed fruit is alive with maggots. The exit openings are characteristic, irregular holes about 2 mm. (.08 in.) in diameter surrounded by a brownish border. They look as though the maggots had gnawed a hole for the head, and then forced the body through. leaving a lacerated border. They may occur anywhere on the apple but are more frequently found where the brown larvæ trails show through the skin. They begin to appear in the early apples about the first of August and may be found until frost in windfalls and in the stored fruit as long as the larvæ remain.

It would seem that the development of the larvæ is so nicely timed that they are not mature until the fruit is ripe. Their development is slower in late and hard fruits. A dozen maggots may infest the same apple though a single one is enough to render it worthless. The maggots have been found in numerous varieties, early and late; sweet, acid and sub-acid, extending from early in July through August, September, October, November, December, January and February. The larvæ usually leave the apples and go into the ground an inch or less and soon change to the pupæ state. The pupæ are occasionally found within the fruit in windfalls and quite frequently in stored fruit. Sometimes the larvæ change on the surface of the ground under decaying fruit. On grass ground they probably change in the debris about grass roots.

In the bottom of boxes, bins and barrels where infested fruit is stored, pupæ may be found in abundance.

Our observations show that if the pupæ are kept in a warm room in a box or bottle, and not covered with earth, they will not hatch. In the cellar and cool store-rooms, where apples are usually kept, it may be different. The pupæ remain in the ground a greater or less length of time, depending on when they enter the pupæ state, soil, location and season. They can be forced by favorable or retarded by unfavorable circumstances in the laboratory, and this is probably true in nature. Specimens kept by Professor Comstock in a warm room all winter, began to emerge May 28th, and continued to appear until July 6th. (He does not say when they entered the ground.) The specimens we transformed, entered the ground in August, September and October; and came forth as flies from May 23d until July 7th, or they finished appearing about the time the first ones appear in nature. This shows forcing. Dr. Goding records the remarkable instance where late larvæ found in fruit in January went into the pupæ state and appeared by Febuary 1st. This would indicate that the later larvæ appear earlier, which is contrary to our experience. Possibly it may be unusually rapid transformation due to forcing. The appearance of the flies again the following summer completes the life history.

Remedies.

Trypeta is an unusually hard insect to destroy. The eggs are laid under the skin of the apple; the larvæ spend their time in the fruit and the pupæ are safely concealed in the ground, within the shrunken skin of the larvæ, therefore, they are well protected from destructive parasites and none are known to infest them. The flies do not seem to be enticed by sweetened poisonous substances and cannot to any extent be trapped. The eggs are so safely lodged in the apple beyond the reach of poisons applied by spraying, that there is no hope in that direction. The only chances left are to destroy the larvæ and pupæ. The larvæ are found abundantly in windfalls, and the pupæ in bins and barrels where fruit has been stored. *Destroying windfalls would prevent the maggots going into the ground, and burning refuse from bins and barrels would dispose of those in stored fruit. These methods are practical, easily applied and should be rigidly enforced.*

There are some *hopeful* and *helpful* features in our struggle with

this pest. The history of its work in other states shows that its ravages have natural limits. Though bad enough, it has not apparently gone on from bad to worse, but has kept within certain bounds. Flies as a class are delicate insects and are liable to many mishaps and great variation in abundance from year to year. Trypeta seems to be confined largely to sheltered locations and sandy soil, and does not from its nature spread rapidly from tree to tree, variety to variety, orchard to orchard.

To *discourage* us is the fact that a new supply of the pest is yearly brought into the State in imported fruit and every railroad town is liable to become a generative center for the pest. Again, unscrupulous orchardists at home, to save loss, knowingly market infested domestic fruit. Infested fruit may be marketed without knowing it. In both cases it is apt to be dumped on the ground and spread the pest. The sale of fruit from one part of the State to another is liable to hasten the spread of the flies.

All things considered, we firmly believe the ravages of this insect can be controlled, if we avail ourselves of the known means to check it. Below is a detailed consideration of useless, preventive and direct methods of coping with the pest.

Useless Methods.

1. Spraying early in the season when the apples are small would do no good, as the flies are not on the wing until July, when the early fruit is fully half or two-thirds grown, and too large too spray with safety. Spraying, even if safe, would do no good as the eggs are inserted under the peel, and the young larvæ in them being protected by a shell are beyond the reach of poisons. The apparent decrease of Trypeta after spraying, mentioned by Mr. Augur in Pomological Society Report, 1887, page 101, must be accounted for by another and independent cause.

2. In confinement the flies are very fond of sugar, yet about the trees, where other flies of several species were regaling themselves on apple juice, we did not see a single Trypeta fly feeding. Sweets poisoned with arsenious acid and corrosive sublimate, and placed on paper in shallow pans in the trees failed to attract them.

3. Sticky fly papers seem to be useless. We exposed several sheets in the branches of a tree where the flies were thick, for three days, and only took a *single* Trypeta fly.

4. It has been suggested "that a practical way to defeat the

work of this insect in great measure is to raise little early fruit." We have no confidence in this method. It is not a remedy. What fruit growers want is a way to check the pest and save them the invaluable luxury of early fruits. Would it not be much better to save the trees and for two years carefully destroy the windfalls and with them the pest? Those who first suggested this method believed the pest confined its ravages to the early fruits. To cut down the early fruit trees would not destroy Trypeta. Experience of Maine fruit growers, and our own observations, show conclusively, that the insect works badly in late and winter fruit, and is known to infest most of the varieties grown in the State. If deprived of the early varieties, a want of food supply would make it worse in the later fruits. We believe that cutting down our fruit trees would "defeat the ends of this insect," but what the profit if in our revenge upon it we at the same time sacrifice our fruit. There is no lazy way to check Trypeta. It will have to be done by a direct, squarely fought battle. We firmly believe we have in the careful destruction of the windfalls the means of destroying the pest.

The Trypeta is not like la grippe, spreading over a State in a day, but it goes slowly from tree to tree, variety to variety, orchard to orchard. The checking of the pest then is largely an individual matter, to be worked out independently in each orchard. We sincerely hope the fruit growers of Maine will give the destruction of the windfalls and the disposal of refuse from apple barrels and bins a fair trial, before passing these methods idly by as "impracticable to any extent."

8. The destruction of our early fruit trees, excepting a few to be left as traps, has been suggested. This method is based upon the erroneous belief that Trypeta works only in early fruits. If we raised no early fruit the early flies would do no harm. The destruction of the larvæ from these trap trees would not lessen the ravages of the later appearing races of flies upon late fruits. Destroying the early fruit would force many of the early appearing flies to find a nidus for their eggs in the later fruit; thus increasing the number of later flies.

Preventive Measures.

1. Keep the orchards in grass and in the fall or spring burn under the trees to destroy the pupæ that are about the grass roots. The experience of fruit growers so far as we know, is to the

effect, that orchards in grass are less affected This is reasonable, because the maggots are weak and cannot enter the ground under such conditions and would be forced to remain above ground about the roots and would be more subject to mishaps. Burning the grass would certainly destroy many.

2. If the orchard is in cultivation, deep spading or plowing in the fall or spring would probably destroy them. The maggots go into the ground less than an inch. The flies are weak and could not reach the surface from any great depth. Stirring the surface of the ground in the spring to expose the pupæ to birds and other predaceous animals has been suggested by Prof. Riley. The above remedies are based upon the supposition that the maggots have been allowed to go into the ground. If the windfalls have been gathered carefully as they should be none would be left to enter the ground, and these preventive measures useless.

3. Orchards on sandy soil and in sheltered places with a southern exposure are worse affected. In planting orchards such conditions might be avoided.

4. Prof. Riley in Amer. Agric., July, 1872, suggested "covering the ground thickly with salt, ashes, lime or other substances" to prevent the maggots appearing, but we do not know that these applications have been tried.

5. Prevent by legal enactment the importation of foreign fruit from localities known to be infested. The pest was undoubtedly introduced into the State by importation of apples, and each year there is a new invoice from Massachusetts in *imported early fruit.* We saw in the Orono market, July, 1889, a barrel of early sweet apples from Massachusetts literally alive with nearly full grown *Trypeta maggots.*

They may be found in Bangor or in any other railroad town in the State when early foreign fruit is exposed for sale. Is an Act to prohibit the importation of early fruits practical? We protect our game by an Act. Infected cattle are destroyed by law. Is the protection of our game and cattle more important than the protection of our fruit? We have no means of accurately telling the annual loss to fruit growers by this pest, but it must be considerable in the State. To many it amounts to from 10 per cent. to 75 per cent. of the crop There are only a few entrance ports and early fruit could be readily inspected, and if found infested confiscated and destroyed or the importation of early apples could be *entirely* prohibited. If fruit growers, knowing the facts, are

contented to allow their interests to be so jeopardized and make no effort to prevent it, they should without complaint bear the consequences. It is a matter of State interest for the pest is almost State wide in its occurrence. As a State, we can much better do without early foreign fruits than suffer the loss of our home products. No matter what methods are adopted to check this pest, they will prove more or less futile, if each year in all the railroad towns of the State, maggots by the hundreds are thrown upon the ground in worthless, infested, foreign fruit.

Direct Methods.

1. The flies are very stupid although they appear otherwise. When resting on the leaves or apples they can readily be taken with a small insect tube or bottle. By placing the mouth of the tube cautiously over them, they are not disturbed, and soon crawl inside. We took thirty this way from a single tree in an hour and a half. Making no allowance for mishaps and supposing a fly lays three hundred eggs and one-half of the flies are females, the progeny of a single fly the third season would be capable of laying nearly seven million eggs. The killing of even a few flies would materially lessen the number and help hold the pest in check.

2. Destroy the windfalls as soon as possible after they drop. This method has been recommended by every Entomologist who has written on the subject, as the *best* way to cope with the pest. It is based upon the positive knowledge that the maggots do not leave the fruit until it drops, and are found abundantly in the windfalls. These maggots if not destroyed enter the ground and appear three hundred-fold stronger the following season for the work of destruction. To destroy the windfalls makes dead maggots of them and dead things can not reproduce. It is common to not gather the fruit of infested trees, but allow it to drop and decay on the ground. *This is a bad practice, as it is the best way possible to multiply the pest.* It is a present loss of time and expense to destroy worthless fruit, but it will pay well in the end.

Two methods of destroying the windfalls suggest themselves:

(*a*) The windfalls may be collected and fed to stock in the yard or pasture. If carried to stock and thrown on the ground in quantities greater than are immediately eaten, there is danger that the maggots might leave them and go into the ground. This might be avoided by feeding no more than are eaten clean, and

storing any accumulated fruit in a tight box or bin, and, finally, destroying the refuse. Every provident orchardist should gather the windfalls as a matter of economy. If not profitable to feed they should still be destroyed to prevent the increase of insect pests and fungi which they harbor. Gathering the windfalls for the express purpose of checking Trypeta has been tried and found effectual. The making of cider from maggoty apples might be profitable, and would afford those who drink it both meat and drink at the same time, though it would not, if known, make a very appetizing beverage. We might as well save the trouble and expense of manufacture and eat the infested apples at once, or as Walsh has tersely expressed it, "Eat the devil as to drink his broth." If not needed to feed stock, they could be thrown into pits in convenient places in the orchard and after frost the refuse covered a foot or two with earth. It would be better to gather the windfalls every day and make thorough work of it. A boy could do it. If gathered every day it would not take much time. If impossible to gather every day, twice a week would destroy many, but would take longer to check the pest. In early varieties the gathering should begin by July 15th, and from late varieties as they begin to ripen and drop.

(b) Allowing enough sheep or swine in the orchard to eat the windfalls, would involve less time and expense and insure probably more immediate destruction. They should be turned in each day for a time, or kept in the orchard all the time from July 15th until the apples are gathered. It is some trouble and expense to destroy the windfalls. A troublesome pest necessarily involves time and trouble, and to exterminate Trypeta will require determined and thorough action.

Thorough and universal destruction of the windfalls is the most hopeful method, and fruit growers are urged to give it a thorough trial for two years.

3. Destroy the refuse from apples stored, marketed or used for home consumption. This is based on the fact that marketed fruit early and late is often alive with maggots. That pupæ in abundance are found in the bins and barrels where fruit has been stored. The chances that these larvæ find the conditions for development are much less than with those that go into the ground from the windfalls, but the pest may be spread by throwing infested marketed fruit on the ground.

(a) Infested, early apples, foreign and domestic, in market

places are a fruitful source of the pest, and fruit dealers should be required to burn or bury all apple refuse and not throw it on the ground.

The maggots are not able to crawl out of a box, and the refuse from market places could be thrown into a tight box or barrel and the maggots prevented from going into the ground. The refuse could occasionally be buried a foot or so deep.

(b) The maggots in stored apples sooner or later leave them and go into the pupa state in the barrels or bins. If marketed without sorting, the pupæ go with the fruit in the barrel and may spread the pest. The sorting floor should be swept if pupæ are found on it, and the refuse burned. In bins and barrels in the cellar the pupæ probably retain their vitality and if not burned the flies emerge in the spring. As a precaution the bins should be carefully swept and the barrels shaken into a tight vessel and refuse burned. Apple refuse from home use, known to contain maggots, should be destroyed and not thrown on the ground.

The writer's observations, to date, seem to indicate that the perpetuation of Trypeta from year to year is largely if not wholly due to the transformation of maggots that go into the ground, and that we have comparatively little to fear from the larvæ found in winter fruit picked and stored after frosts.

The pupæ found in barrels in December and placed in a jar in the cellar, without dirt, have not transformed. Some of the same lot put in earth December 25th have not changed. Maggots allowed to emerge from apples and transform in a box without dirt have not changed to flies. These facts would seem to indicate that pupæ exposed in open barrels for any length of time will not transform. Again, many of the larvæ in hard winter fruit die and do not reach maturity. It is not uncommon to find winter fruit full of the old trails of half-grown larvæ and the maggots dead in the channels, and the apple in a fair state of preservation. The subject needs further investigation, and the writer is at work upon it. Meanwhile it is best to destroy all pupæ found upon sorting floors or in bins or barrels.

The careful destruction of the windfalls and pupæ from stored fruit is, with little trouble or expense, within the control of fruit growers, and amounts to making an effectual trap of all trees infested.

The remaining sources of Trypeta, domestic and foreign marketed fruit, are not so easily controlled. Fruit growers should be

careful not to market infested fruit, and try to control the importation of early fruits. Great importance attaches to a knowledge of the pest and its habits, so that its first appearance in an orchard will attract attention and lead to prompt action against it.

Critical Remarks Upon the Anatomy of Trypeta.

Walsh, in the original description says the eyes are *black*, and no one seems to have corrected this error. The eyes fade in cabinet specimens and are dark, but even in these they have a decidedly greenish tint. The eyes are greenish in life, and in varying light give green, rusty brown and beautiful steel blue reflections. They are rarely variegated with brown patches. Walsh says: "The tip edge of the four basal segments of the abdomen white above." He seems to have overlooked the first basal segment, which is not at all white. The facts are, that in *both male* and *female* the white bands begin on the *second* basal segment and in the male involve the second, third and fourth, and in the female the second, third, fourth, fifth and occasionally the sixth. Loew makes the same mistake and says indirectly that there are only five segments to the female abdomen, while there are really *seven*. (See Plate I, Figure 3.) Walsh and Loew seem to have examined only a *single* female. Comstock apparently overlooked the basal segment of the female abdomen, as he says, the white bands "are borne by the *first* to the fourth segments inclusive." The sixth segment of the female abdomen is apparently represented only by the *tergite*, the segment being very narrow at the sides and below. The seventh bears the sheath and ovipositor contained within it. Walsh lets the reproductive system so severely alone, that it is certain he did not see the ovipositor, or he would have considered so important an organ. From Loew's account it would appear that he mistook the last segment of the abdomen for the ovipositor, and described that segment for it. The abdomen of the male as figured by Comstock is shriveled or distorted. We have before us twenty-five males and all show the ovate form, broadest at about the second segment. If there is any difference the male abdomen is broader in proportion to its length than that of the female. The form of the abdomen as figured by Walsh and Riley is essentially correct. Prof. Lintner also calls attention to the correct form of the abdomen.

The basal lobes of the wings are more prominent and rounded

than shown in Prof. Comstock's figure and the caudal margin sinuous, the sinuses being located where the second and third black bands touch the margin. The outline of the outer black bands of the wings are not curved and continuous (as shown in Comstock's figure) but quite irregular as shown in the corrected cut of the wings, Plate 1, Figures 1 and 2. There is also a subcostal vein above the one that is armed with spines, which is not shown in Comstock's figure, and to this the cross vein in front of the second black band joins and is not attached to the subcostal as shown in Comstock's figure.

Walsh says: "The tips of the four hind paws tinged with dusky." This statement usually applies to all the paws. Walsh, in describing the larva says: "That at the base of the first segment behind the head the spiracles are located." Comstock says: "There are at the union of the first and second segments pale brown tubercles, the cephalic spiracles." Comstock's figure represents them so located. If Walsh regarded the head as one segment, then his vague statement would imply, that he believed the spiracles located between the second and third. After examining many specimens, both alive and dead, we feel confident there are three segments in front of the spiracles as shown in Plate I, Figure 3. Prof. Comstock's figure of the full larva shows it at *rest* with the head and first segments telescoped and the anterior third of the body thickened. When fully extended the maggot is much more pointed in front. The hooks are less blunt than shown by his figure. The cut of the larva given in Saunders' Insects Injurious to Fruits is entirely misleading.

Prof. Comstock is the only one who has seriously studied the anatomy of this insect since Walsh and Loew's time, and though we have not confirmed some of his observations, yet his paper is really the only contribution to the internal anatomy and histology of *Trypeta pomonella* up to this time, though others have contributed to a knowledge of its habits and distribution.

Critical Remarks Upon the Life History of Trypeta.

The first reference we find to the notion that codling moth work bears any relation to Trypeta, occurs in Walsh's First Annual Report, 1868, where Mr. W. C. Fish is quoted as follows:

"I have found that in most cases the fruit had been previously perforated by the larva of the codling moth before being inhabited by the apple maggot."

Walsh evidently did not endorse this, as he says: "The eggs are inserted by the ovipositors of the flies into the flesh of the apple," a statement, which our observations confirm, though we are at a loss to know upon what data Walsh affirms so positively, as he did not describe the eggs, ovipositor, or make record of having witnessed oviposition. Walsh says Trypeta "never penetrates to the core," a statement not warranted by our observations, as maggots have frequently been found in the core, and sometimes the core almost eaten, as shows in Plate III, Figure 5. Walsh says Trypeta "*probably* feeds upon our native crabs." It should be noticed that he does not make record of having found it in crab appels. The statement restricting the appearance of the flies to July is partial knowledge rather than error and the result of limited observations. The other statements recorded by Walsh our observations have confirmed.

The matter upon the food habits and distribution of Trypeta was in print before we had access to Prof. Riley's article (Amer. Agric., July, 1872, p. 263) where the fact that the fly has been bred from wild crab apples is recorded. Prof. Riley has not experimented, but offers the following remedial measures, based upon the habits of the insect, that are worthy of a trial, viz: "covering the ground thickly with salt, ashes, lime or other substances" to prevent the emergence of the flies; "feeding the infested fruit to hogs or converting it into cider, and stirring or disturbing of the ground in spring so that birds and other predaceous animals may get at the pupæ." Prof. Riley also notices the fact that Trypeta sometimes affects the core of apples. "In N. Y. Semi-Weekly Tribune, Dec., 1876. Prof. Riley quotes Mr. Augur as saying that Trypeta "seems to prefer sweet apples but is found in R. I. Greenings and many other varieties, illustrating the wide range of the work of Trypeta. The statement made by Prof. Riley that the larvæ appear in late summer would be true only of the later races of flies, as the young maggots are found early in summer in early fruits. Prof. Riley implies that the flies are on the wing *only* in July, and that the eggs are *only* laid when the fruit is full grown, conclusions not warranted by our observations. He seems to endorse Walsh's view that the flies oviposit *in* the fruit, but afterwards has evidently changed his views, as he recently wrote the writer, that the insertion of the eggs into the flesh of the apple through the skin "is opposed to everything which we know regarding the egg laying habits of *Diptera*."

Passing by the writings of Loew, Packard and Glover, who record nothing new upon the habits of Trypeta, we come to Prof. Comstock's Report. The statement that crab apples are infested by Trypeta is not based upon observation. Prof. Comstock writes us he has not observed Trypeta in crab apples. Prof. Riley seems to be the only one who has bred the fly from crabs, and his article recording this fact, (Amer. Agric., July, 1872) seems to have been overlooked by recent writers, their views being founded upon Walsh's statement of probability recorded above. It is to be doubted whether Trypeta occurs throughout the country where haws grow. We have not found apple maggots in haws in Maine, nor in Arkansas where the genus Crataegus is represented by a large number of species, nor in Iowa, but abundantly in Northern New York. The conclusions reached by Prof. Comstock, that Trypeta is "fastidious," and confines its ravages to a few varieties of fruit and is "much more apt to infest early apples," are not warranted by our observations. We find it attacks a wide range of varieties early and late, acid, sub-acid and sweet, and affects the early varieties not from fastidiousness but because the early races of flies are most abundant and appear when the early fruit is in proper condition to receive eggs.

The statement: "We seldom see the Trypeta until about the first of September, and never in green fruit," quoted by Prof. Comstock from a letter written by Mr. Hicks and left unchallenged, is incorrect. Prof. Comstock endorsed this view as follows: "According to my observations and all published accounts, the apple maggot does not occur in the apple till the latter part of the summer."

The eggs are laid in half grown fruit as early as July 1st, and maggots occur in abundance in July before early fruit has commenced to soften, and pupæ commence to be formed by August 1st. The statement that "in the autumn when the larvæ are full grown, they leave the apple and enter the ground," expresses only a part of the truth. Larvæ are transforming from August 1st until the middle of October from maggots found in apples in the orchard, but large numbers of young larvæ are stored with fruit and enter the pupa state in the bins and barrels, transforming sometimes as late as December, January or even February. The statement that the insect remains in the pupa state during early summer would not apply to the early appearing races of flies found on the wing by July 1st.

The contributions to the habits of Trypeta made by Prof. Comstock and not recorded by Walsh that our observations have confirmed, are that the larvæ go about one-half inch into the ground to transform and that in confinement the flies emerge earlier than in nature. Prof. Comstock seems to have studied the histology of Trypeta rather than its habits, and his contributions in that direction are more important.

Prof. Comstock suggests two remedies: the destruction of the windfalls and grafting the trees into later varieties and leaving a few early fruit trees for traps. We endorse the first, but the second we do not, as it is based upon the erroneous belief that Trypeta works almost exclusively upon early apples.

Prof. Cook rejects Walsh's position that the eggs are inserted in the flesh of the apple and erroneously says "the flies seek a nidus for their eggs *on* the apple." Again, "Several eggs are often laid *on* a single fruit." He incorrectly restricts the appearance of the flies to July, the occurrence of the maggots to September and early October, and pupation to early October. Again, he incorrectly says, Trypeta "is only found in the apples in early fall, and as it prefers soft, mellow fruit it is much more destructive to fall apples. I have found a few in winter fruit. From the fact that it only attacks fall fruit, it is, on the whole far less to be dreaded than the coding moth larva." The maggots occur in apples from early July until February, and attack early fruit, and in Maine several winter varieties badly, and it tunnels the whole fruit rendering it worthless. Its occurrence in time and its range in varieties being about the same as that of the codling moth and its work much more destructive, for these reasons *alone* we would regard it a worse insect. But its range over the country being much more limited and in a State its occurrence less universal, the damage done by it at present is less than the injury by codling moth larvæ. Prof. Cook has added the western localities, Michigan and Wisconsin, to our knowledge of the geographical distribution of Trypeta in cultivated fruit, and also recently has detected the apple maggot in plums and cherries in Northern Michigan.

Prof. Lintner perpetuates the errors of those who have written before him, by restricting the appearance of the flies to July, the egg laying to late July and August, the first appearance of larva so late as September, the pupation so late as autumn. He also advocates the view that the eggs are deposited *upon* the apples,

and the novel view that they are placed "near the *calyx* end, where the fruit *may* have been already burrowed by the apple worm." It is not certain from this statement what method of entrance into the fruit by the larvæ is advocated, but it may be implied that those from eggs laid in apple worm holes enter that way, and the others when hatched crawl to apple worm holes or bore directly through the peel where they are located. It makes but little difference now, as both are known to be wrong. Prof. Lintner evidently did not observe a fly with the ovipositor extended, or he would not have rejected Walsh's statement, and said the "blunt ovipositor could not pierce the peel" of the apple. He corrects the error that Trypeta is confined to early fruits, and recognizes its wider sphere of action. Prof. Lintner, under the head of "Desiderata in the Life History of Trypeta," mentions several points which need to be determined. The questions asked by him are all considered in this Report.

The statement made by Walsh, Comstock and Perkins, that Trypeta has not been found in cultivated apples in Illinois needs correction. In *Orchard and Garden* (October 1889, page 192) Mr. A. B. Cordley records its occurence in Illinois.

The following statements made by Prof. Perkins have not been confirmed: "The eggs must be deposited upon the apple. The ovipositor is too soft and blunt to pierce the skin of the apple. The maggots do not eat the apples until well advanced toward maturity. The eggs are not deposited on the fruit until the end of autumn."

Prof. Perkins expresses doubt about the eggs being locally placed on the apple, and implies that the larvæ gnaw through the skin when hatched, or sometimes enter codling moth holes. He also gives facts disproving Comstock's position that Trypeta is chiefly fonnd in early apples. He also adds Vermont localities to our knowledge of its distribution and suggests several important lines of research, which were undertaken by the writer and are considered in this Report.

Mr. A. B. Cordley, in the article referred to above, records the occurrence of Trypeta in plums and cherries in Northern Michigan, and also speaks of Trypeta having been found in Illinois. The article seems to have been written to report the above facts, as nothing else is new, and many of the errors of previous writers are reiterated.

Mr. G. C. Davis in *The Ohio Farmer*, November 9th, 1889,

records the same facts reported by Cordley, but adds nothing new and leaves all the errors of previous writers unchallenged. He however, makes the novel and reasonable suggestion, that Trypeta may have acquired the habit of feeding on cultivated apples, "because cultivated apples became more plentiful or thorn apples less numerous."

The fact that Trypeta will feed upon plums and cherries is quite important as showing the adaptability of this insect to new food. Great care should be exercised before drawing conclusions and it is usually best to not decide a species without obtaining the perfect insect by transforming the larva. We have no reason to doubt the insect was *Trypeta pomonella*, though the species was decided from the larva and pupa. There is a European species, *T. signata*, Meigen, that infests the cherry, barberry and several other fruits, and *T. Ludens*, Loew (the Morelos Orange Fruit Worm) infests oranges in Mexico. The larvæ and pupæ of flies, especially of the same genus, are so nearly alike, and it being known that other species of the genus infest fruits, we hope Cook, Cordley and Davis will confirm their observations by rearing the flies from infested plums and cherries.

In Maine Agricultural Experiment Station Bulletin, No. 2, (Second Series), Prof. Harvey records the following new facts regarding the life history of Trypeta:

(*a*) The discovery of the eggs; the number of eggs the female deposits: that the eggs are inserted from *time* to *time*, *one* in a place, by means of a *sharp* ovipositor, through the skin of the apple; that the eggs are deposited in the fruit *before it is ripe* and in early fruit in early July; the time required for the eggs to hatch.

(*b*) That the larva becomes full grown in from four to six weeks; that they leave the apple through characteristic openings in the skin, and on grassy ground probably hybernate about the grass roots; that the larvæ stored in fruit leave it and go in the pupa state in the bins or barrels; that they occur in the fruit earlier and during a longer time than before recorded.

(*c*) That the flies are on the wing longer than before recorded; that the later races of flies affect the later fruit.

Additional new facts will be found recorded in this Report and some of those recorded in the above Bulletin modified or extended.

The Abstract of Maine Agricultural Experiment Station Bulletin No. 2 (Second Series), which occurs in *Station Record*, Vol. 1, No. 2, page 73, is incorrect in the following particulars:

It ignores the writings of Walsh, who should have received credit for the first account of the larva, pupa and flies, and implies that the credit should be given Prof. Comstock. Again, it gives Prof. Comstock the credit of describing and figuring the insect in *all* its stages. Prof. Comstock does not claim this honor, as he says (U. S. Agricultural Report, 1881-2, page 196): "I will now give an account of each of the stages of this insect, excepting the egg, which has not been observed." Prof. Comstock did not discover any of the stages of this insect, and the flies and larva were first figured by Walsh, and the pupa by Riley. Comstock's cuts of the fly, larvæ and pupa and anatomical details of the larva, though not the first published, are original. To the writer belongs the credit of discovering the eggs which are first described and figured in this Report. Again, the abstract implies that Prof. Harvey has simply confirmed the results of investigation by Prof. Comstock and has added nothing new regarding the life history of Trypeta. Credit should have been given for the facts spoken of above, which were recorded in Bulletin No. 2 for the first time. Again, the abstract gives Prof. Comstock the credit of discovering the remedial measures suggested by him, and makes the writer confirm his conclusions. Prof. Comstock advocates only two methods: destruction of windfalls and growing only later fruits and the leaving of a few early tree for traps. The first method advocated was not the result of Prof. Comstock's observations, but those of Mr. Isaac Hicks of Long Island. Prof. Comstock says: "The most practicable way of lessening the injuries caused by this pest are those suggested in the letters quoted above." Besides Prof. Riley had suggested destruction of the windfalls as early as 1872.

The writer has only confirmed the first of these methods but rejects the second. The second method is based upon the erroneous belief that Trypeta mostly confines its depredations to early fruit. The observations of other Entomologists and those of the writer show that this is not the case. The statement that Prof. Harvey confirms the results of investigations of Prof. Comstock in this and several other particulars is incorrect.

The above review of the literature on Trypeta shows how correct observations may be discarded for a long time and surmises and theories based upon incomplete or erroneous observations be reiterated and perpetuated.

It also suggests the importance of careful work on the part of

Entomologists that their writings be as free as possible from errors and that great care should be taken, especially in quotations, to keep theories and surmises distinct from facts obtained by careful research.

Notes on Other Insects.

While studying Trypeta, observations were incidentally made upon other insects. The late appearance of Codling moth larvæ in apples, examined in 1888, would suggest that the eggs of the spring brood may be deposited on apples after they are considerable size. This would have an important bearing upon the proper time to spray with arsenic solutions. It might be better to wait until apples are as large as marbles than to spray when they are only the size of peas as is done in Maine. Codling moth larvæ, one-half grown, were found in apples in November, 1888. In 1889 we noticed much insect work in stored late apples, which appeared to be that of half grown codling moth larvæ. It would seem that there is a second brood of this insect in Maine, but that the larvæ are only half grown when frost appears and they probably perish. The second brood cannot be reached by spraying and considerable damage is done by it. The fact that but few apples affected by the Plum Curculio were noticed after August, would indicate that this insect works early in the season and that the apples affected drop early. The cuts were quite abundant early in July, showing this insect does considerable damage to the apple. A large number of the punctures were abortive, no larvæ being found in them, while frequently dead larvæ were noticed in the channels made by them. Only a small per cent. matured and transformed. This would seem to show that this insect does not find in the apple the most favorable condition for its development. Its injuries are not confined to the apples in which the larvæ mature but all apples stung either drop or are poisoned. Those that do not drop are dwarfed and growth in the vicinity of the punctures arrested. This insect was considered in Report for 1888. Considerable work, supposed to be that of the Ash-gray Pinion was observed the past season. The larvæ of this moth eats holes into the sides of apples.

EXPLANATION OF PLATES.

These plates were prepared by the Moss engraving process. Where a short line occurs by a figure it indicates the natural size of the object.

EXPLANATION OF PLATE I.

Figure 1. The female fly of the apple maggot (*Trypeta pomonella*, Walsh) magnified about eight times. Modified from a drawing made by Mrs. A. B. Comstock and found in the United States Agricultural Report, 1881-2, Plate XIV. The abdomen is entirely original and shows the ovipositor extended, and also the sheath. The black bands, veining and basal lobes of the wings are also modified to agree with the writer's observations.

Figure 2. The male fly of the apple maggot (*Trypeta pomonella*, Walsh) magnified about ten times. The abdomen original. The bands, veining and basal lobes of wings modified as stated under Figure 1. The genitalia are not shown, being retracted beneath the abdomen.

Figure 3. The larva of the apple maggot (*Trypeta pomonella*, Walsh) magnified about twelve times. A side view of the maggot with the head extended and the hooks protruding, original and showing three segments in front of the spiracles to agree with the writer's observations.

PLATE I.

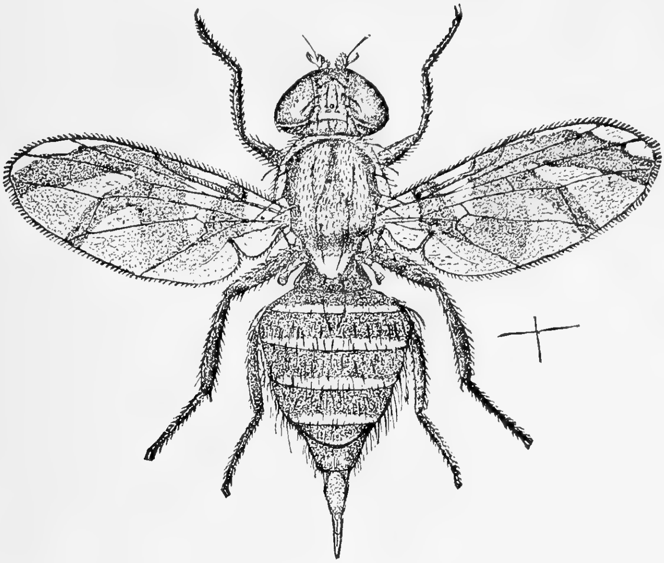


Fig. 1

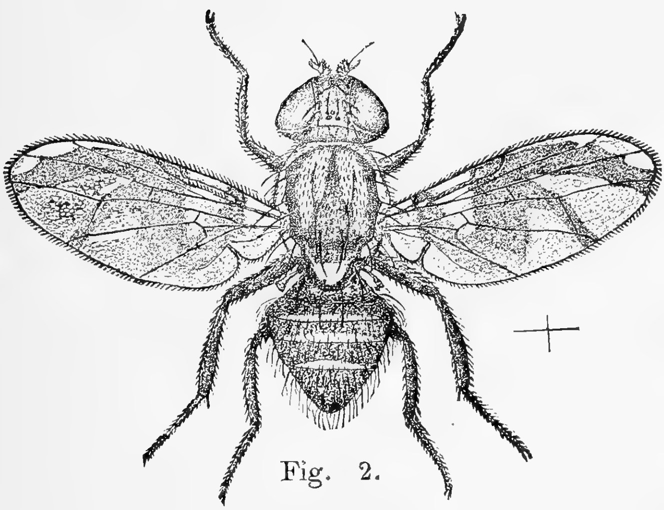


Fig. 2.

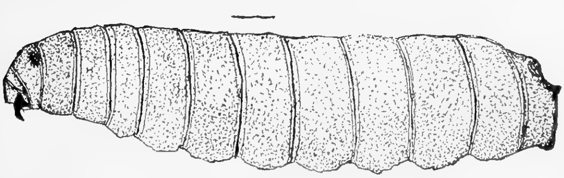
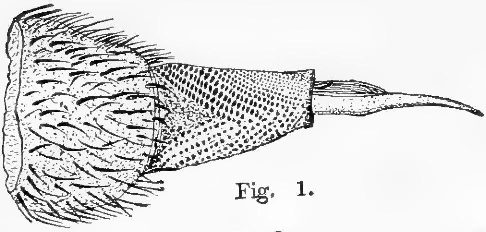


Fig. 3.

APPLE MAGGOT.

(*Trypeta pomonella*, WALSH.)

PLATE II.



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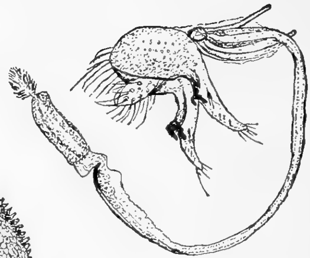

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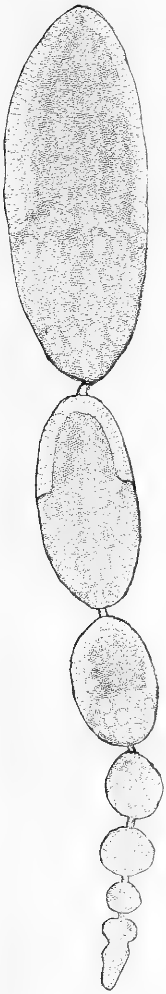


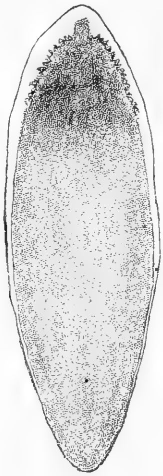


Fig. 6.

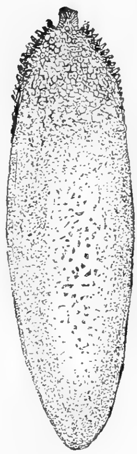
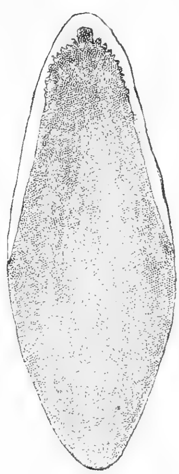
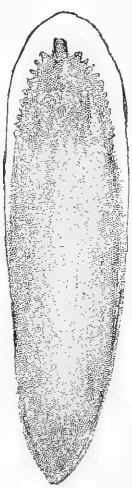


Fig. 8.

Fig. 3.





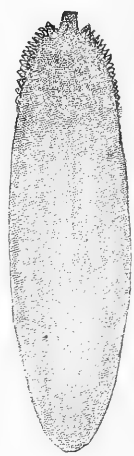


Fig. 4.

Fig. 5.

Fig. 7.

Fig. 9.

APPLE MAGGOT.

(*Trypeta pomonella*, WALSH.)

EXPLANATION OF PLATE II (Original.)

The Apple Maggot.

(*Trypeta pomonella*, Walsh.)

Figure 1. Last abdominal segment, sheath and extended ovipositor (female) magnified about thirty times.

Figure 2. External genital apparatus of male (enlarged.)

Figure 3. Last abdominal segment, sheath and ovipositor from below, magnified about thirty times.

Figures 4 to 9. Eggs in different stages of development. Figure 4 shows eggs as found attached in the ovary.

Figure 8. Shows the reticulated markings on the egg shell at the pedicellate end of the egg.

EXPLANATION OF PLATE III.

THE APPLE MAGGOT.

(*Trypeta pomonella*, Walsh.)

Figures 1a, 1b, 1c and 2 are copied from Mrs. A. B. Comstock's admirable drawings in United States Agricultural Report, 1881-2, Plate XIV.

Figures 3 and 4 were photographed by Mr. L. H. Merrill from slides prepared by the writer.

Figures 5 and 6 are original.

Figure 1a. Side view of anterior end of the larva, showing jaw system, portion of trachea and cephalic spiracle.

Figure 1b. Anterior end of larva viewed from above, showing jaw system and spiracles.

Figure 1c. Enlarged view of caudal spiracle showing the three transverse slit-like openings and the four groups of bristles.

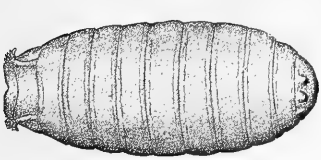
Figure 2. Dorsal view of the pupa, magnified about ten times.

Figure 3. Portion of apple peel showing the puncture made by the ovipositor of the female, magnified about thirty times.

Figure 4. Portion of apple peel showing an exit-opening of the larva, magnified about five times.

Figure 5. Cross section of High Topped Sweeting showing advance work of full grown larvæ, natural size.

Figure 6. Cross section of a Winthrop Greening showing the work of half grown larvæ, natural size.



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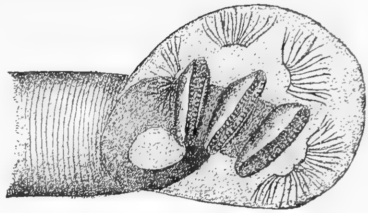
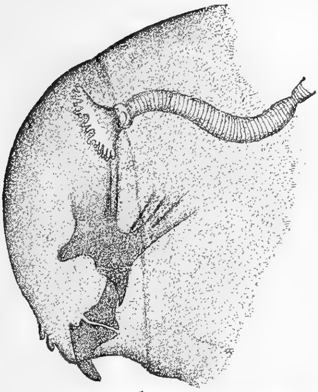
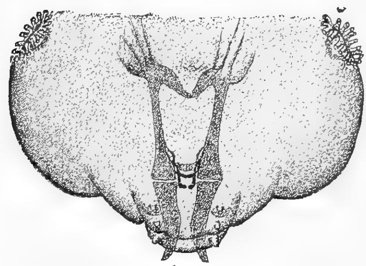


1c



1a



1b

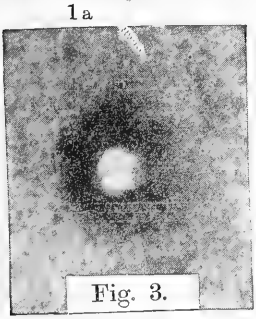


Fig. 3.

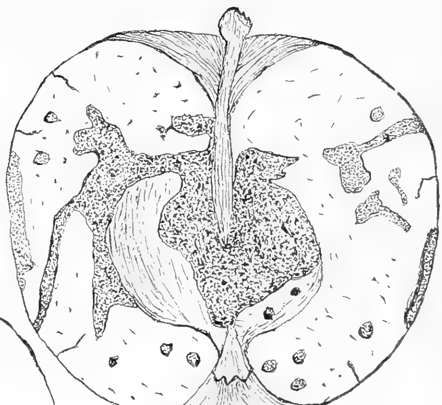


Fig. 5.

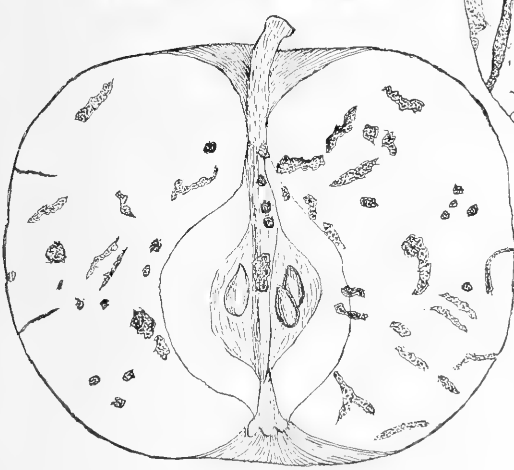


Fig. 6.

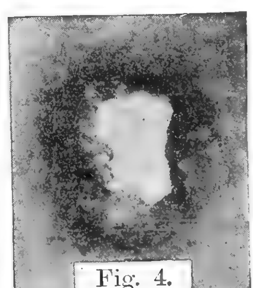
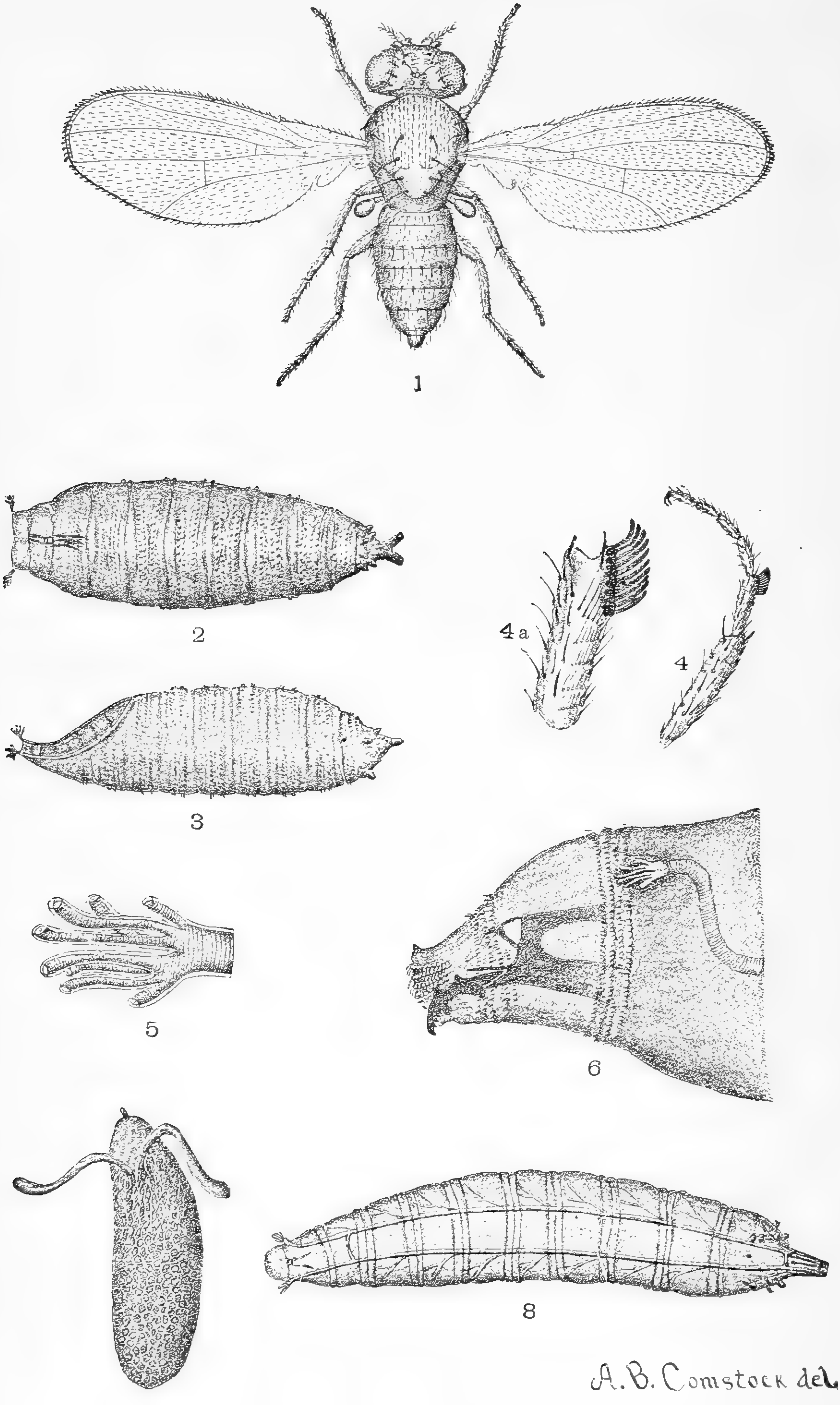


Fig. 4.

(*Trypeta pomonella*, WALSH.)



VINE LOVING POMACE FLY.

(Drosophila Ampelophila, LOEW.)

EXPLANATION OF PLATE IV.

(After Comstock.)

(*Drosophila Ampelophila*, Loew.)

Figure 1. Adult.

Figure 2. Ventral aspect of puparium.

Figure 3. Lateral aspect of puparium.

Figure 4. Tarsus of prothoracic leg of adult male; 4a, tarsal appendage.

Figure 5. Cephalic spiracle.

Figure 6. Lateral aspect of cephalic end of larva.

Figure 7. Egg.

Figure 8. Larva.

INSECTICIDES.

The necessity of using insecticides needs no argument. There are so many insects that feed upon vegetation, and do much damage to forests, orchards, field and garden crops, that it has become necessary to destroy or hold them in check. The use of poisons that will insure wholesale destruction at a moderate cost is the only practical method of coping with them, therefore insecticides have come rapidly into use within a few years. It is important that all orchard owners should become converts to this policy so as to insure universal application of insecticides. It would be better if some other way could be found to destroy insects, as the use of poisons is attended with more or less danger to man and stock. There is yet considerable prejudice against the use of poisons, and many are deterred from using them, especially in orchards in grass or in pastures, for fear of poisoning stock. The wholesale use of Paris Green upon potatoes has made us familiar with poisons and demonstrates that when properly used the danger is small. It should, however, always be remembered that too great care cannot be exercised with poisons and the following precautions should be carefully observed:

1. Insecticides should be carefully labeled *Poison* and kept out of the reach of children.

2. Never handle poisons with the bare hands. Oil the hands as a precaution and cover any sores with court plaster. Light leather gloves would be advisable.

3. While spraying, keep to the windward of the trees. Wash thoroughly after spraying work. Keep children out of the orchard while such work is going on.

4. The trees should not be sprayed until there is much dripping, but as a precaution stock should be kept out of the orchard for a week or two after spraying. The amount of poison that gets on the grass in properly conducted experiments is not enough to poison stock, but proper precaution is advisable. Prof. Cook sprayed in the ordinary way, and then cut and fed the clover under the tree to a horse, without producing symptoms of poisoning. The amount of poison put on an apple tree for codling moths is so small, that if it all remained, no poisonous effects would be noticed by eating an ordinary amount of the fruit. The usual formula for spraying trees is one pound Paris Green to eighty gallons of water and three gallons to a large tree. This would make

253 grains of the poison per tree. Now supposing half of it fell upon the fruit and half on the leaves and branches, and the tree bore ten bushels of apples, this would make 13 grains to a bushel of fruit. There are about 200 ordinary sized apples in a bushel. This would leave only seven one-hundredths of a grain to an apple which is much less than a poisonous dose. Considering that the poison is applied when the fruit is small and long before harvest, and that the rains would wash much of it off, the danger of poisoning is small.

5. In dusting vegetables or plants with dry poisons care should be taken not to inhale them. See that the dry dust is not carried by the wind to berries, vegetables or fruit soon to be gathered. It is best not to plant berries or vegetables near orchards or shrubbery that have to be sprayed.

Conditions.

To have insecticides work properly the material must be good and the application properly made.

1. As there is considerable adulterated material on the market it is best to procure poisons, even at a higher price, from reliable dealers who will warrant their goods.

2. Great care should be exercised in properly mixing the material. When it is only held in suspension and not soluble in water it should be kept thoroughly stirred while being applied.

3. The application should be by an even fine spray and with force enough to reach every part of the tree or plant.

4. If the material seems to burn the leaves it is too strong and should be diluted.

5. The proper time to spray is of great importance. It should be done when the insect, or fungus is in the proper stage of its life to be reached by the poison.

6. If a hard rain follows the spraying it should be repeated. Several applications are often necessary during the season.

Common Insecticides.

The injurious insects that can be destroyed by the application of insecticides are of two kinds: Those provided with biting jaws for eating the foliage of plants, and those provided with sucking apparatus and living upon the juices of plants. Those having biting

jaws take the substance of the leaves into the stomach and can be killed by poisoning the leaves. Those living upon the juices can be reached only by the application of substances which act externally; stopping the breathing pores, irritating the skin, producing offensive odors or acting as mechanical barriers. The poisons in common use that act internally, applied in the form of a powder or in suspension, are paris green, London purple and white arsenic. Those used externally in the form of a powder are hellebore, pyrethrum, sulphur, lime, plaster, ashes and dirt. Those applied in the liquid form are kerosene emulsion, whale oil soap and sulphur, strong soap suds, tobacco decoction, bisulphide of carbon, benzine, gasoline and coal tar.

Insecticide Apparatus.

Material used for destroying insects is applied either as a dry powder, or dissolved, or suspended in water, or some other liquid. The kind of apparatus used would depend upon the method of application. *For Applying Powder*, powder blowers are useful. These have long discharge tubes, by means of which the powder is carried considerable distance. The following machines have claimed more or less attention for their efficiency: The *Woodason Bellows*, made by Thomas Woodason, Philadelphia, Pa. These throw the powder 8 or 10 feet and with a ladder small trees can be wholly reached. The *Orchard Gun*, made by Leggett Bros., New York, is provided with a tin tube in sections 5 to 16 feet. There is a fan that works with a crank. Above the fan there is a can to hold the powder, which has a perforated bottom. The crank works a sliding plate, which lets the powder into the tube at each revolution. This instrument is efficient for some kinds of work. Weight, 7 lbs.

For applying liquids a good force pump and nozzle are essential. Below we consider some good pumps and nozzles that have been tried and found efficient.

For small operations any good hand pump, aquaject, syringe, or hydronette would answer the purpose.

When the orchard exceeds five or ten acres a larger machine would be more desirable.

Any of those mentioned below, or a good pump of any manufacture, arranged for attachment to a barrel or tank, and provided with a suitable hose and nozzle, would answer the purpose.

Pumps with two discharge pipes allow two sprays to be thrown

at once. One man can work the pump and two do the spraying. When only one spray is needed the other discharge pipe can be provided with a return tube to the tank or barrel and serve as an agitator and keep the liquid stirred. Where larger machines are used a team is almost necessary, the apparatus being placed in a wagon and the spraying done from it. A hand cart, a wheelbarrow, or a stone boat and horse can be used. If high spraying is to be done, (large orchard or shade trees,) a long hose will be found necessary. With a light ladder, and a hose long enough, the tops of high trees can be reached, or the hose can be attached to a light bamboo pole and the spraying done from the wagon or ground.

A good quality of 1-4 inch cloth insertion rubber tubing is strong enough for all ordinary purposes. A larger sized hose would be too heavy, unwieldy, increasing the work and cost.

It would be difficult to get an extension pole strong enough and light enough to support a long, heavy hose. Thirty feet of discharge hose is sometimes necessary for high spraying.

Below we give the addresses of reliable firms, who manufacture spraying apparatus. We would advise those who intend to purchase apparatus to write for circulars and examine the claims of the various kinds offered before deciding. As the outfit purchased will depend upon the use, and as this may not be clear to all, the *writer* will take pleasure in answering questions addressed to him regarding spraying apparatus.

A good outfit for heavy operations embracing the best materials need not exceed twenty dollars. The outfit may be purchased in parts of diffierent firms or complete outfits are offered by manufacturers at from $10 to $50, according to style.

Responsible Firms.

Thomas Woodason, 451 E. Cambria Street, Philadelphia, Pa.; Leggett Bros., New York; W. & B. Douglass, Middletown, Conn.; Rumsey & Co., Seneca Falls, N. Y.; Field and Force Pump Co., Lockport, N. Y.; Robert T. Deakin & Co., Philadelphia, Pa.; Nixon Nozzle & Machine Co., Seneca Falls, N. Y.; Thomas Summervile & Sons, Washington, D. C.; Columbia Brass Works, 1216 D St., Washington, D. C.; Adam Weaber, Vineland, N. J., and P. C. Lewis, Catskill, N. Y.

Acknowledgment.

We desire to acknowledge the donation to the Experiment Station of the following pieces of spraying apparatus: From Rumsey & Co., Seneca Falls, N. Y., a Florida Spraying Pump complete; from Nixon Nozzle & Machine Co., Dayton, Ohio, a Little Climax Pump complete; from C. P. Lewis, Catskill, N. Y. a Combination Force Pump; from Gould Mf'g Co., Seneca Falls, N. Y., a Magic Nozzle; from Thomas Summerville, Washington, D. C., a Cyclone Nozzle and a Vermorel Improved Nozzle.

The above pieces of apparatus were placed on exhibition at the Norway meeting of the State Pomological Society, where they were explained by the writer. They were kindly turned over to the Experiment Station to be used in experimenting and illustrating lectures on spraying to the classes in Economic Entomology at the Maine State College. The writer has tried the above pieces of apparatus and can recommend them.

Description of Apparatus.

The cuts illustrating this article were furnished free of expense by the various firms whose spraying apparatus they represent.

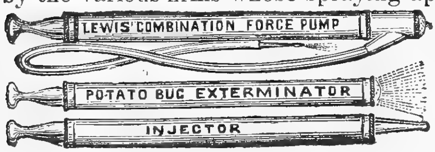


Fig. 1.

Figure 1 shows Lewis' Combination Force Pump, manufactured by C. P. Lewis, Catskill, N. Y., and sold for $6.00. This is a handy instrument to have about the farm and has the element of cheapness. It is a combination of three instruments in one; a force pump, an agricultural syringe and a veterinary syringe. It can be used to wash wagons and windows, sprinkle gardens and lawns, and also to spray shrubbery, potatoes and small orchards.

Belonging to the above class of pumps may be mentioned: The Gould Portable Brass Force Pump, sold for $9.00; the Aquaject, made by Rumsey & Co., Seneca Falls, N. Y., for $9.00. (This price includes suction and discharge hoses and a rose sprinkler.) And the Hydronette made by Rumsey & Co., and including hose, nozzle and sprinkler, sold for $8.00.

LITTLE CLIMAX

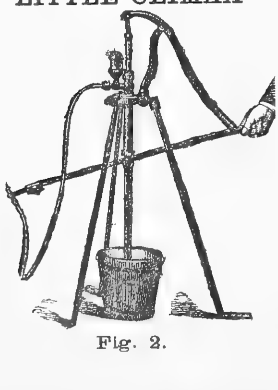


Fig. 2.

Figure 2 represents the Little Climax Pump manufactured by the Nixon Nozzle and Machine Co., Dayton, Ohio.

"It is made of iron and brass, all parts that have to bear any considerable strain being malleable. The pump is firmly bolted to a strong iron base, supported on three legs made of gas pipe. These legs are unscrewed and the pump is put in a

small, neat box for shipping, and they are easily screwed into place by the purchaser. The legs are turned out at the bottom sufficiently to make them stand firmly. There are furnished with this pump four feet of 1-4-inch cloth insertion, rubber tubing and two climax nozzles; also suction hose, as shown in the cut, to draw the liquid from the bucket or other vessel, as the case may be. There is also furnished the rod for holding the hose, as shown in the cut; with this the spray may be thrown straight upward, out at any angle desired, or horizontally, without touching the hose or turning a screw. This is suitable for spraying in green houses, flowers and shrubs on the lawn, or for garden and small orchard work. Price $10.00."

We are using the Little Climax pump and Nixon Nozzle for some spraying work this season. We had the pump fitted like Climax No. 2, with a 12-foot hose and barrel attachment. Arranged that way it cost about $13.00.

CLIMAX PUMP NO. 2.

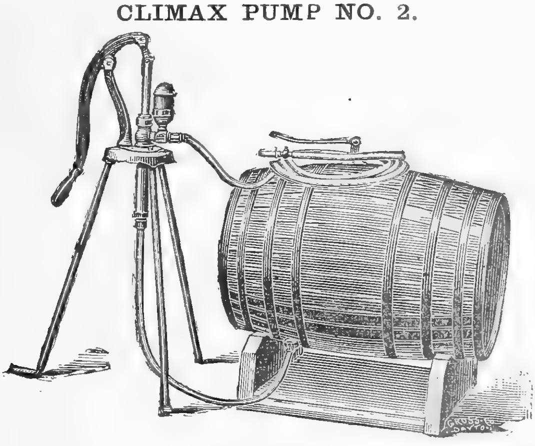


Fig. 3.

Figure 3 shows Climax Pump No. 2, fitted with long hose, barrel attachment and agitator. This pump is like the Little Climax in construction, only larger. It can be attached to any kind of vessel or tank by means of our brass connections in ten minutes; or the suction hose can be dropped into a barrel, trough or cistern with equal success. This pump is sold complete, with twenty feet of hose, two nozzles and the necessary connections for it, as shown above. The barrel or vessel is shown in the cut to give an idea of a practical manner of connecting it. Any person can prepare this barrel and rack, as shown above, in a few minutes. The

agitator, the handle of which is shown on the top of the barrel, is a very complete and successful thing. It costs $1.00 extra. Price without agitator and barrel $15.00. This apparatus is provided with the Nixon Nozzle and especially adapted for large orchard work.

THE FLORIDA SPRAYING PUMP.

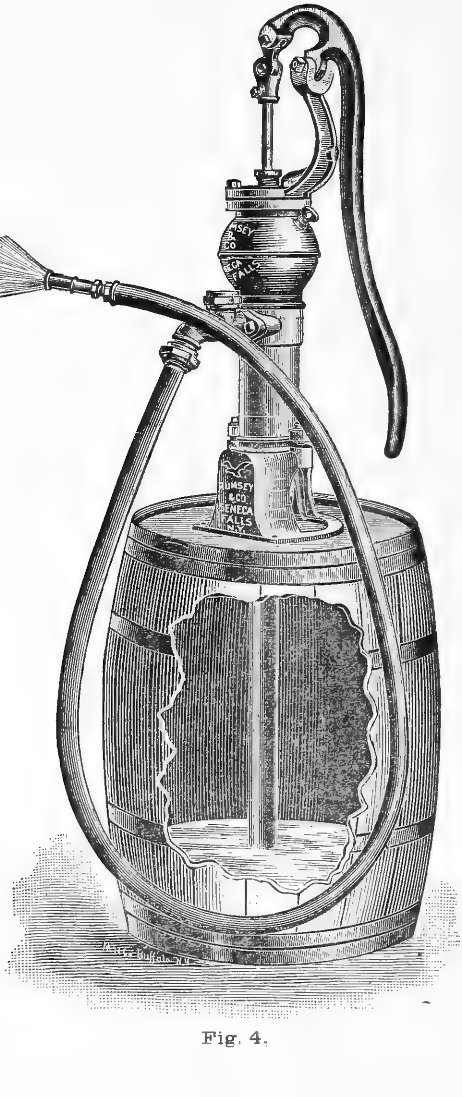


Fig. 4.

Figure 4 shows the Florida Spraying Pump manufactured by Rumsey & Co., Seneca Falls, N. Y. It consists of a force pump with hose and nozzle attached and a pipe to extend to the bottom of a barrel. Price, with 3 feet of hose, spraying nozzle, and sufficient 1 1-4-inch gas pipe to reach the bottom of an ordinary barrel, $12.00.

Figure 5 represents the Gould Double-Acting Spraying Pump, manufactured by the Gould Mf'g. Co., Seneca Falls, N. Y. This pump is arranged for either hose or gas pipe discharge, or spraying. Being double-acting it throws a continuous powerful stream. Both discharge orifices can be fitted with hose and two sprays used at once, or one of the discharges can be used at once, as a return pipe to mix the contents of the barrel. Fuller directions accompany the pump.

Gould's Double-Acting Spraying Pump.

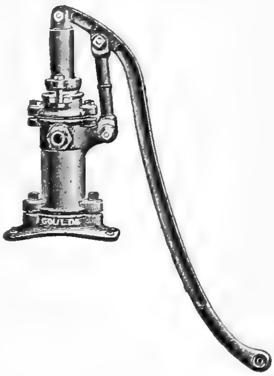


Fig. 5.

SIZES, PRICES, ETC.

No.	Dia. Outer Cylinder.	Suction.	Double Hose Discharge.	Double Pipe Discharge.	All Brass Piston or smaller Cylinder and Brass outer Cylinder.	All Brass Piston or smaller Cylinder and Iron outer Cylinder.
2	$2\frac{1}{2}$ inch.	1 inch.	$\frac{3}{4}$ inch.	$\frac{1}{2}$ inch.	$14.00	$8.50

With metallic fitted lower valve, $2.50 net, extra.

☞ *These Prices include a brass Suction Basket, but no Pipe, Sprayers, Hose or Couplings. We can furnish any fittings as ordered, at lowest market rates. Advise in orders, whether wanted for hose or wrought iron pipe suction and discharges, and if Pumps are wanted fitted complete for any special work we should be so advised.*

The Japy Pump offered for sale by the Columbia Brass Works, 1216 D St., Washington, D. C., for $21; the Eureka Pump manufactured by Adam Weaber of Vineland, N. J., and sold for $21.65; and a machine constructed by Mr. Roland Thaxter, for experiments at the Conn. Expt. Station at a cost of $9.80, are arranged to strap on the back so the spraying can be done while walking.

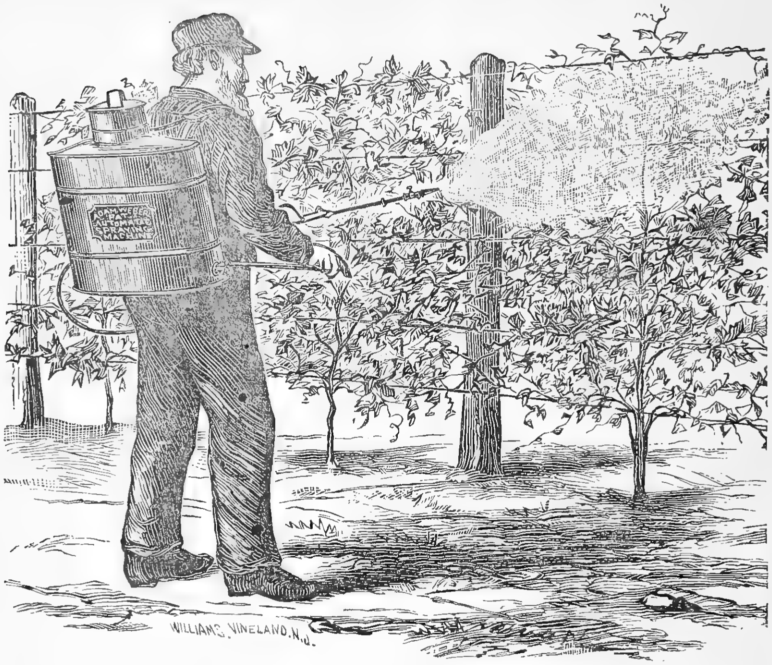


Fig. 6.

Figure 6 shows the Eureka pump in action. It is provided with a reservoir, a pump operated by a lever, and an air chamber to insure a continuous stream. By means of a hose any suitable nozzle can be attached. These pumps are especially handy for spraying low plants and shrubbery.

Fig. 7.

Figure 7 shows the Automatic Spraying Machine, made by Adam Weaber that accompies the Eureka pump.

The Japy and Eureka pumps are quite expensive, and to meet this objection, Mr. Thaxter, Mycologist for the Connecticut Experiment Station, devised and used with satisfaction an apparatus which is figured and described in Bulletin 102, Connecticut Agricultural Experiment Station, March 1890, from which we take the following cut (Fig.8) and description. "This apparatus consists of an ordinary copper wash boiler of the smallest size and a force pump

of the "hydronette" or "aquanette" pattern. A tank made like a copper boiler but about half as large as the smallest wash boiler can be made with the fittings represented in the cut, of copper with tight fitting tin cover for about $2.50, at any tin house. A piece not quite large enough to admit the hose of the

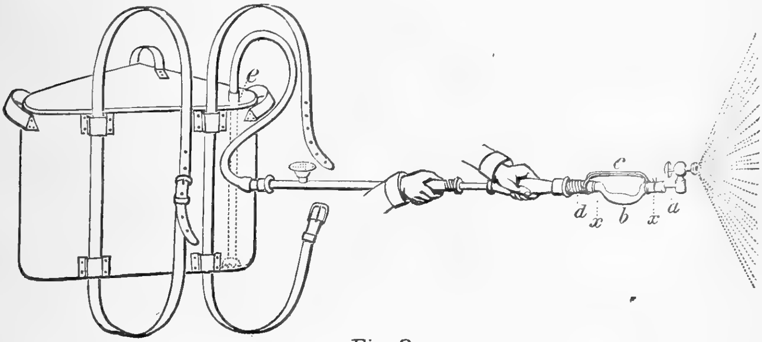


Fig. 8.

hydronette is cut out from the edge of the boiler cover at *e*, and a short collar of tin soldered into it with a slot broad enough to allow the hose to be pushed into it sideways. (This socket is misdrawn in the cut, the broken rim of the cover not being connected vertically with edges of the collar as they should be.) The hose when pushed into the socket therefore projects just enough to be firmly held against the side of the boiler when the cover is shut down. A couple of wire catches may be necessary to hold the cover on firmly, if it is not very tight; and in addition the boiler should be fitted with straps as in the cut, or in any other convenient manner so that it can be carried on the back of the operator.

Since pumps of the "hydronette" pattern do not throw a steady stream, acting only when the piston is driven back, some appliance is necessary to produce an even, continuous spray. This is very readily provided as shown by the cut. A piece of 5-8-inch heavy but elastic rubber "*tubing*" (*b*)—hose will not answer—is fastened to a "Vermorel" nozzle (*a*) at one end (*x*) and to the hydronette nozzle (*d*) at the other end (*x*), by winding it tightly with a few inches of small copper wire. Unless the rubber tube is used with care it is liable to burst. This is readily obviated by taking a rectangular piece of strong, cotton cloth and sewing the two opposite edges together firmly so as to make a cloth cylinder 5 1-2 inches in circumference which may be slipped over the 5-8-inch tubing and wound firmly at either end so as to keep the rubber from becoming unduly distended. Fresh rubber is better than that which

has lost its elasticity to any extent from age. The two nozzles (*a*) and (*d*) are then connected by two heavy copper wires (*c*) fastened by winding once or twice around each nozzle. The Vermorel nozzle is thus held firmly in place, and, as the wire will stand any amount of bending, the direction of the stream is easily regulated in this way. The length of the copper wire and rubber tubing may be increased as desired; for spraying the under side of the leaves of low shrubs, for instance, the wire being bent so as to send a vertical stream; but six inches of tubing is about as short a length as will furnish sufficient elasticity for producing a steady stream. The pump may be also used for spraying trees by using the necessary length of small hose furnished with a spray nozzle at one end, and connected at the other with a piece of rubber tubing long enough to allow free motion to the piston. The hose can then be fastened to a light pole and the body of the pump so fastened to its base as to allow free movement of the piston.

The apparatus can of course be used without the copper boiler, by carrying the substance to be sprayed in a pail or other vessel; but when liquids are used, such as the Bordeaux mixture or Paris green in water, which have to be kept stirred while being used, the boiler gives far less trouble, since the motion of the body keeps its contents stirred up while in use. The apparatus has thie additlonal advantage that, by procuring an extra hydronette nozzle or a coupling which will serve to attach the sprayer as described, the spray nozzle and its adjuncts may be screwed off as a whole when not in use, and the ordinary nozzle substituted; so that the pump may be also employed for any of the many purposes for which it is useful. The cost of this apparatus, not including straps or strainer, is about as follows:

Copper boiler (No. 7)	$3.25
Hydronette pump	4.00
Wire and rubber tubing	.20
Fittings to boiler	1.00
Vermorel nozzle	1.25
Total	$9.70

In "The Journal of Mycology," Vol. 6, No. 1, March, 1890, p. 26; we find the following from the pen of Prof. B. T. Galloway: "We have had the matter of providing a cheap, serviceable knapsack pump under consideration for some time, and can now positively announce that the machine will be on the market in a

few weeks. The pumps will be made in two or three styles, and as there is no patent on them, we hope manufacturers throughout the country will be able to offer them at about $12, thus placing them within the reach of all."

THE "BOSS" NOZZLE.

Figure 9 represents the "Boss" Nozzle, manufactured by Rumsey & Co., Seneca Falls, N. Y. "It will throw a coarse or fine spray, or a solid stream."

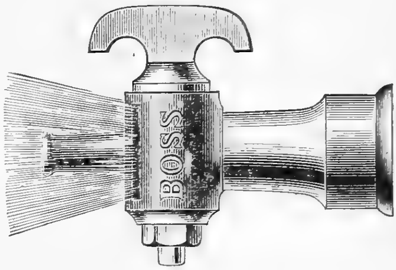


Fig. 9.

Size	¾ inch.	1 inch.
Per Dozen. Nickel Plated	$12.00	$14.00

THE "GEM" NOZZLE.

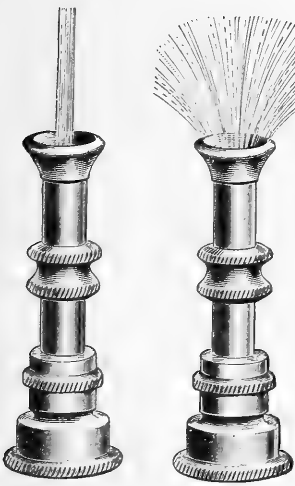


Fig. 10.

Fig. 10 represents the Gem Nozzle offered for sale by Rumsey & Co., Seneca Falls, N. Y. "By means of an adjuster near the butt, it can be graduated to throw a solid stream, a spray or be shut off entirely, while the pump is in operation "

Size	¾ inch	1 inch
Per Dozen	$9.00	$12.00

Figure 11 represents the Magic Nozzle, offered by the Gould Mf'g Co., Seneca Falls, N. Y. "Will throw coarse or fine spray; a large or small solid stream by revolving nozzle part way around."

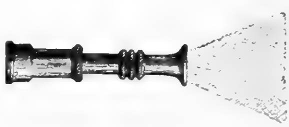


Fig. 11.

Price, ¾ inch, per dozen	$10.00
Price, 1 inch, per dozen	12.00

THE CLIMAX NOZZLES.

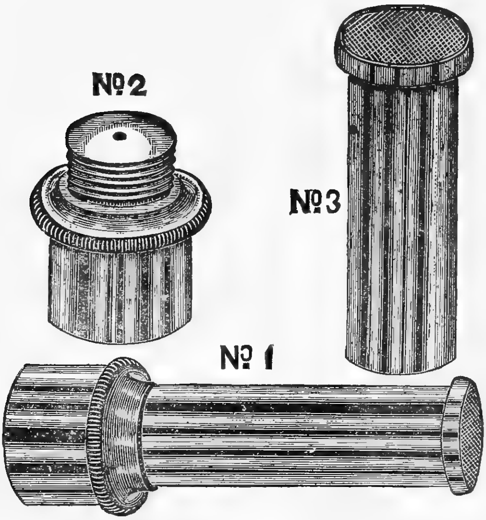


Fig. 12.

Figure 12 illustrates these nozzles. No. 3 shows the outer end covered by a wire screen, which cuts the water into spray. No. 2 shows nipple end of same. No 1 shows the nozzle entire.

The nozzles are simple in construction, cannot get out of order, and are very durable, being made of brass They are all fitted with standard-pipe thread, and will fit corresponding sizes of gas pipe and hose coupling. They are made of various sizes, numbered from 1 to 6, and will produce spray from the density of fog to any desired coarseness as may be required. Nozzles Nos. 1 to 5 are intended for conservatory, flower garden, orchard and field use. No. 6 is for lawn and street use. Price, $1.00.

Besides the nozzles mentioned above, are the Cyclone Nozzle with the Eddy chamber and the Improved Vermorel made by Thos. Summerville & Sons, Washington, D. C., the former sold for 50 cents and the other for $1.50.

FRUIT TESTS.

The following is a list of the large and small fruits which the Station has under cultivation. This list will be greatly enlarged in 1890.

The object of this work is to test the value of these fruits, not only in the vicinity of the Station, but in various other parts of the State. It is especially necessary to secure a trial of new or untried varieties of apples in several localities, as a success or failure of a particular apple in one place should not be accepted as conclusive with regard to the whole State. To this end it is proposed to distribute scions to apple growers in different sections of Maine, to be used in top grafting, as in this way definite results will be soonest reached. Scions were cut last fall from nearly all the varieties of apples given in the list, many of which will be distributed the coming spring.

LIST OF FRUITS SET AT THE STATION IN 1889.

APPLES.

Alexander.
Bellflower.
Canada Russett.
Chenango.
Early Strawberry.
Fallawater.
Fameuse.
Gravenstein.
Hubbardston.
Hurlburt.
Jonathan.
King of Tompkins.
McIntosh.
McLaughlin.
Mother.
Newtown Pippin.
Northern Spy.
Peach of Montreal.
Peck's Pleasant.
Pewaukee.
Red Bietigheimer.
Red June.
R. I. Greening.
Rome Beauty.
Roxbury Russet.
Schiawasse Beauty.
Scott's Winter.

PLUMS.

Bavay's Gage.
Bradshaw.
Coe's Golden.
Damson.
Duane Purple.
Gen. Hand.
German Prune.
Imperial Gage.
Italian Prune.
Jefferson.
Lombard.
Prince Englebert.
Yellow Egg.

PEARS.

Josephine of Malines.

CHERRIES.

English Marella.
Gov. Wood.
Large Montmorency.
May Duke.

GRAPES.

Amber Queen.
August Giant.
Bridgton.
Champion.
Concord.
Delaware.

Apples.

Smith's Cider.
Stump.
Twenty Ounce.
Wagner.
Walbridge.
Yellow Transparent.

Currants.

Lee's Prolific.
Red Dutch.

Gooseberries.

Industry.

Blackberries.

Erie.
Snyder.
Taylor's Prolific.
Wild Blackberry.

Raspberries.

Carmen.
Cuthbert.
Golden Queen.
Gregg.
Herstune.
Rancocas.
Shaffer.
Wild Raspberry.

Grapes.

Diana.
Empire State.
Hartford.
Lady.
Moore's Early.
Prentiss.
Salem.
Vergennes.

Strawberries.

Belmont.
Bubach.
Chas. Downing.
Crescent.
Cumberland.
Golden Defiance.
Henderson.
Jersey Queen.
Jessie.
Jewell.
Jucunda.
Lady Rusk.
Manchester.
Mt. Vernon.
Sharpless.
Triomphe De Gand.
Wilson.

REPORT OF VETERINARIAN.

DR. F. L. RUSSELL.

BREEDING STATISTICS.

Last year there was sent out with the Annual Report the following blank form to be filled out and 'returned in July '90. Although the time mentioned for the return of the blanks has not yet arrived a few have already been received. It was not expected that all the data asked for would be furnished in all cases, but it was expected that some of the returns would be complete, especially those from the Experiment Stations and from leading diarymen. The returns thus far have justified our expectations.

It is impossible to say just what use will be made of these statistics, but it is our purpose to continue to accumulate them with the hope that they may help to solve some very important problems of stock breeding. The science of stock breeding, if in its present state it can be called a science, is in a very unsatisfactory condition. Theories in regard to breeding problems are abundant, but there are very few well established facts from which any reliable conclusions can be drawn.

The hearty co operation of all who receive our blanks is desired in order that we may get as complete returns as possible.

CAPONIZING EXPERIMENTS.

Last season we undertook to conduct some experiments with capons and cockerels to determine the comparative growth in feeding them with different rations.

Owing to unforeseen difficulties the experiments were not a success. But we regard the poultry interests of the State as among the most important, and intend to give increased attention to the subject. Considerable time will be required to arrive at results of value, but it is regarded as a promising field for careful investigations.

HOG CHOLERA.

During the past five or six years a great amount of time and money has been expended in studying the contagious diseases of swine. If the results obtained have not satisfied the expectations of the most sanguine or the demands of those who fail to appre-

ciate the difficulties that have been encountered, enough has been accomplished to amply compensate for all the trouble and expense. Ten years ago the most confused ideas and conflicting opinions in regard to the whole subject were held even by those best informed; to-day it can be safely said that while there is doubtless much to learn, there is hardly a disease of any of our domestic animals that is better understood than are the contagious diseases of swine.

The importance of investigating this subject is apparent when we have to face an annual loss in the United States alone of over $15,000,000, leaving out of account the incidental losses due to the decreased value of the farms and farm crops in localities where the pork raising industry has been destroyed or seriously injured. No section of the country has been spared, but the loss in many sections has been about in proportion to the number of hogs kept. The fatality has been so great in some sections well adapted to the cheap production of pork that the business has practically been given up.

As near as can be learned from the imperfect records kept, Hog Cholera was first brought to this country from Europe about fifty years ago. At first gradually and later quite rapidly it spread through the country until it has come to be quite a serious question whether we will not have to give up the profitable production of pork on a large scale on account of its ravages.

Since 1879 the Bureau of Animal Industry has been giving particular attention to the disease of swine, endeavoring to gain such information as would be of benefit to the pork raising industry. The Experiment Stations of the West and South have also done much work in the same direction.

When this work was commenced by the Bureau of Animal Industry very confused ideas prevailed in regard to the whole subject, and with the imperfect methods of investigation then available little apparent advance was made. Investigators were groping in the dark, endeavoring to discover the real cause of the diseases, hoping that with a knowledge of the cause a remedy could be found. In 1885, with the improved methods for bacterialogical investigation perfected by Prof. Koch, of Berlin, Dr. Salmon, Chief of the United States Bureau of Animal Industry, discovered in cases of Hog Cholera that he investigated a bacillus which he calls the Hog Cholera Bacillus. Subsequent experiments and investigations by Dr. Salmon resulted in the discovery

of another bacillus, differing in size and habits of growth when cultivated artificially, which he calls the Swine Plague bacillus, and he has been able to prove that this second germ is the sole cause of the disease which he calls Swine Plague.

Swine Plague seems not nearly so common as Hog Cholera, and the symptoms of the two diseases are so nearly alike that it requires an expert to distinguish between them without making a bacteriological investigation. For the purposes of this article the diseases will be classed together and called Hog Cholera.

With the discovery of the cause new light was thrown upon the contagious diseases of swine, and the importance of the subject was sufficient to lead many investigators to turn their attention to the subject, so that the work done by Dr. Salmon and his assistants has been repeated and verified by many others who have added to the work done by the Bureau of Animal Industry. It has been my privilage to study several outbreaks of Hog Cholera in the vicinity of Baltimore where it prevails every year to a serious extent, and since coming here I have been called upon to investigate an outbreak in this State where ten out of twelve exposed hogs died. From the Baltimore cases as well as from those in this State I obtained cultures of the Hog Cholera bacillus with which I have been carrying on experiments to determine the hitherto undecided point of the degree of heat required to destroy the germs.

I have found this point of difference between the Hog Cholera and Swine Plague germs. The Hog Cholera bacillus will live at a temperature that destroys Swine Plague. Both of them are destroyed at a temperature of 57° (137° F.) when they are exposed for a period of ten minutes. It is not my purpose in this article to go into the details of the experiments that I have conducted, as in the main they have been but a repetition of experiments made at Washington, but with conditions more favorable than could be obtained in a locality like Washington where inoculation experiments are liable to be interfered with by natural infection. In confirmation of the results obtained by the Bureau of Animal Industry I may say that I have obtained both Swine Plague and Hog Cholera by inoculation, the time taken to kill inoculated animals depending on the amount of the virus introduced.

I wish to bring to the attention of farmers of the State such

facts in regard to the contagious diseases of swine, as may be of benefit to them.

Here in Maine we may well congratulate ourselves upon the fact that we suffer comparatively little from the effect of contagious diseases among our domestic animals. If it were in order in this connection I would like to enlarge somewhat upon the reasons for this favorable condition of affairs, for the reasons are not hard to find.

What is true in a general sense is especially true of Hog Cholera, so that compared with some sections of the country we are unacquainted with the disease and its ravages.

At varying intervals we have an outbreak occasionally affecting so many hogs as to cause serious loss to a few individuals, but it does not spread very generally on account of the lack of communication between the affected pens and other hogs. How to avoid this comparatively small loss that we suffer is a problem well worth considering, and enough is now known of the ways in which the disease is communicated from one locality to another so that we ought to be able to entirely protect ourselves. In the West and South where large herds of hogs are kept under such conditions that there is constant danger that they may contract contagious diseases from neighboring hogs, and where the pastures and water courses are often constant sources of infection, the problem of adequate protection is a serious one that often admits of no solution. Here where all the channels of infection are so completely under our control it is our own fault if we lose any hogs from Hog Cholera. Almost every outbreak in this State can be traced directly to hogs imported for breeding purposes, or to infested meat scrap that has been fed to hogs. The danger from this last cause is so slight in this State where but little infested meat scrap is fed that practically we may disregard it, but the danger from imported hogs is not appreciated as it should be. It is not *every* imported hog that has Hog Cholera, but so widespread is this disease that the only safe course to pursue is to assume that every imported hog is an infected animal until a sufficient time has elapsed to prove him sound. By observing this rule much trouble and expense will be avoided at a slight cost. All that reasonable prudence would suggest as necessary is that the newly imported hogs be placed in pens by themselves, separated as far as possible from pens containing other hogs, and cared for in such a manner that nothing with which they come in

contact can come in contact with other hogs until three or four weeks have passed and they show no signs of sickness. This simple precaution would have prevented many outbreaks. The expense is so slight that no one is justified in endangering his own hogs and perhaps the hogs of his neighbors by neglecting it.

Prevalent as Hog Cholera is, every sick hog is not affected with it. In making a diagnosis the history of the case is very important. It is hardly possible for one or two out of a number of hogs that are kept together to have Hog Cholera without others soon becoming affected. When all the hogs in a pen are taken suddenly sick and it is not possible to trace any connection between them and some outbreak of Hog Cholera, it is well to consider whether their condition is not due to the feed or care they are getting. There is no evidence to show that Hog Cholera ever develops in a place where it has not been brought by affected hogs, or some of the diseased products of affected hogs. And such a thing as a permanently infected locality is probably unknown, although the Hog Cholera bacilli will live and multiply in the waste food and wet places about the pens where sick hogs are kept, and will even live in dry earth for two or three months sometimes.

The most prominent symptoms of Hog Cholera are a loss of appetite, considerable elevation of temperature, constipation followed before death by very fluid discharges. In some acute cases there is little diarrhœa before death; in other cases it is a marked symptom for some days. Death may occur within two or three days of the time the first symptoms are noticed, or it may occur after three or four weeks. Usually the skin on the under side of the neck, thorax, abdomen and on the inner side of the thigh presents a bright red appearance before the death of the animal. After death the principal lesions are found in the large intestines, which are studded with what Dr. Salmon terms ulcers. In the cases that I have seen, these "ulcers," instead of exhibiting a loss of substance, are actually thicker than the surrounding tissue. They vary in size from a mere speck to nearly an inch in diameter. The larger ones have a thicker outer ring and a depressed center and are usually nearly black in color. Their border is sharply defined and they can often be easily removed, leaving a depression that extends into or completely through the muscular coats of the intestines. These "ulcers" are usually the most abundant in the cæcum about the ilio-cæcal valve. The

spleen is commonly somewhat enlarged. The liver may be normal or thickly studded with yellowish white necrotic specks the size of a pin head and smaller. The kidneys do not often present any prominent lesions, although they may be quite hyperæmic and studded with small hemorrhages. The lymphatic glands are usually distended with blood and present a very red appearance. The lungs are usually entirely normal.

There is no known method of treatment that is at all satisfactory, and no treatment should be ever attempted.

As soon as the nature of the disease is known it is best to kill and burn all the affected hogs, or bury them so deep that there is no danger that they will ever come to the surface. All the exposed hogs that fail to take the disease should be kept strictly by themselves until ready for the butcher. After the hogs are all out of the infected pens, the pens should be cleaned out and then left vacant for at least six months.

Summary.

Hog Cholera, a contagious disease of hogs, is caused by a bacillus, Hog Cholera bacillus, which multiplies in the large intestines principally, but also is found in the blood and all parts of the body before death. The disease occurs in all parts of the country but particularly in the West and South where large herds of hogs are kept. We have occasional outbreaks in Maine, usually due to infected hogs brought from other States for breeding purposes.

The best method of preventing outbreaks is to put all imported hogs in pens separate from other hogs, and keep them entirely separate for three or four weeks. If during this time they show no signs of sickness they can safely be put with other hogs.

All affected hogs had better be killed and deeply buried or burned, but mistakes are often made and care should be exercised in making sure the sick hogs have Hog Cholera before they are destroyed.

Pens where affected hogs have been kept should be cleaned and left vacant for six months.

PARTURIENT APOPLEXY *("Milk Fever.")*

I contribute this article to the Annual Report of the Experiment Station to satisfy, as far as may be, a want that is felt among the dairymen of the State for some knowledge that will

enable them to contend more successfully with what many of them recognize as one of their most invincible enemies.

This disease, that, with scarcely any warning, attacks the best cows in a herd, and in spite of everything that is done for the animals' relief, almost always proves fatal, so that many have the impression that it is incurable, may possibly be robbed of some of its terrors, if a little light can be thrown upon the causes that bring it about and the way it may be prevented. After everything is said that can be said there will still be many points left in obscurity, for the most careful observers are not entirely agreed as to the nature and causes of the disease, but enough is known to prevent most of the loss that it now occasions.

Many cows are said to have "milk fever" when they are really suffering from an entirely different trouble, but making all due allowance for false reports, the fact remains that "milk fever" occasions much more loss among our diary stock in this State than any other disease. The loss is aggravated by the fact that it is the very best cows that have the disease, and they are always affected at the most profitable period of their lives.

Parturient apoplexy is a disease peculiar to cows. A few cases have been reported in mares and goats but evidence is lacking to show that they were genuine cases. Only cows that are large milkers and have arrived at their full maturity are affected. There is no evidence that there is any other general predisposing cause of parturient apoplexy besides the excessive development of the milk producing qualities. There are particular breeds that seem to be predisposed but these are notably the great milk producing breeds. Prof. Thomassen writing from Utrecht, Holland, says that in the district where he has practiced, parturient apoplexy was absolutely unknown forty years ago. At about that time, in order to improve the stock of the country, they commenced to import Holsteins from the northern prairies. With the bringing in of these great milk producing animals parturient apoplexy became common. In other countries the same observation has been made. Increased liability of loss from this disease is part of the price that is everywhere paid for cows of great milk producing capacity. But this liability is limited to such a short period of time that we can well afford to take the necessary precaution to protect the cows from its effects. Cows seldom suffer from parturient apoplexy until they have their third calf, and it always affects them within a week of calving. If

cows have calved and done well for a week there need be no further fear of parturient apoplexy. The most fatal cases occur almost immediately after parturition, and usually when the calf has been delivered with very little effort on the part of the cow. In the cow, that, on account of her great milking qualities is liable to have parturient apoplexy, certain other conditions have been noticed that seem to favor its development and prevent a favorable termination. Among these may be mentioned a high condition of flesh, constipation, a previous attack of the disease, and an excitable disposition. At the time of parturition, a sudden change of food, particularly an increase in quantity or an improvement in quality, exposure to cold or wet, the early removal of the calf and infrequent milking are liable to bring on the trouble. The symptoms of parturient apoplexy are by no means constant, but certain conditions that are always present render it an easy matter to diagnose the disease even if one has no experience with it.

The affected cow has calved within a week without any exhausting effort. She has had at least one calf previously and is in a fleshy condition. Without any warning she is taken sick. The appetite is entirely gone; the eyes stand out prominently; the horns and forehead are hot and the rest of the body cold. There is a general anxious, distressed appearance. After stepping about uneasily with the hind legs for a time she falls over, and if able to rise, soon falls again without the ability to get up. There is a gradual loss of consciousness and a more or less complete paralysis of parts of the body. Ordinarily the cow will remain quiet, with the head turned back towards the flank, but occasionally she will plunge about madly, so there is danger of her breaking her horns or injuring those about her. The secretion of milk is ordinarily suspended. The temperature is below the normal, occasionally as low as 95° (F.) The pulse is increased in frequency, sometimes reaching 100. Respiration is slow and deep. The nervous troubles cause constipation and the retention of the urine. The duration of the disease may vary from one to three or occasionally five days. Probably about seventy-five per cent. of the affected animals die. Recovery when it occurs is very rapid. The most fatal cases are those that are affected almost immediately after calving. Those cases that occur after two or three days are not apt to be so severe and they more readily yield to treatment. When the trouble comes on slowly there is more hope

for the animal than when the disease progresses rapidly.

The most effective treatment for parturient apoplexy is the preventive treatment. The old adage that "an ounce of prevention is worth a pound of cure," certainly holds good here. The "pound of cure" in this case is nearly always unavailing, while the judicious application of the "ounce of prevention" is very effective. It is so easy to decide what animals are predisposed, and they are in danger for so short a time, that no one can afford to neglect to use reasonable precautions to protect the most valuable cows of his herd. The fact that some dairymen with the best of stock rarely ever lose a cow from parturient apoplexy while others frequently suffer such loss is a suggestive one, and forces us to the conclusion that much depends upon the conditions under which the cows are kept.

First, then, avoid those conditions that are known to favor the development of the disease. At the critical time do not make any radical change in the feed; see that the udder is frequently emptied of milk; avoid exposing the cow to wet or cold; keep in a quiet place and guard against all exciting influences.

The food for some time before and for a week after parturition should be moderate in quantity and easily digestible. If the cows are in the barn, feed moderately on the best of hay and a few shorts, potatoes, apples or roots. Regulate the bowels by the feed, so that there will be no tendency to constipation. Water should be given frequently and with the chill taken off. Cows will usually do well at pasture, but if it is necessary to put them under cover to protect them from cold storms or a too hot sun, they should not be given dry food, but cut grass for them and feed it fresh. If these directions are followed there will be little need to resort to the various "cow drinks" that are widely advertised for use in such cases, and which, if given indiscriminately, are calculated to do more harm than good.

For the lack of wise precautions, and sometimes in spite of them, cases of parturient apoplexy will occur. At such time the very best veterinary skill available should be promptly secured, for much depends upon prompt treatment, provided it is of the right sort, and any other is worse than useless at any time. It is impossible to give directions for treatment that will be universally applicable because no two cases will be exactly alike or require quite the same treatment. Great care should be exercised in giving medicine, particularly after the cow is down and unable to

rise, as in this condition she will not be able to swallow on account of the paralysis of the pneumogastric nerve. Medicine poured into her while in this condition is likely to pass to the lungs and prove speedily fatal. If given early rather more than an ordinary dose of physic may be beneficial. To a large cow give about a pound and a half of epsom salts with a pint of molasses and an ounce of ginger. Dilute before giving with at least two quarts of warm water. Stimulants are usually indicated and as often as every twenty-four hours give half an ounce of carbonate of ammonia dissolved in a pint of water, or four ounces of alcohol. The application of a bag filled with snow or pounded ice to the head in the region of the horns is advisable, and the rest of the body should be kept covered with blankets. It is well to cover the cow with a large blanket wrung out of hot water and outside of it a dry blanket. The urine is usually retained and it must be drawn to avoid serious consequences. The milk should be frequently stripped and the udder kept empty. The longer death is delayed the better the prospects of recovery, provided the cow is well cared for.

REPORT OF METEOROLOGIST.

President Fernald, Meteorologist to the Station.

MAINE EXPERIMENT STATION.

Lat. 44°, 54', 2'' N. Long. 68°, 40', 11'' W.

For twenty years meteorological observations have been taken at the Maine State College, and summaries of the same have been published yearly in the College reports. These summaries relate to the larger part of the phenomena regarded as meteorological.

It is not the purpose of the Experiment Station to duplicate this work of the College, but rather to make a somewhat careful study of certain meteorological conditions, an acquaintance with which cannot fail to be of value to those engaged in practical agriculture.

The first problem of the nature referred to, to which the Station has addressed itself, is a determination of the percentage of moisture in forest as compared with that in open field.

The hygrometers used for this purpose were manufactured by H. J. Green of New York, and were read by Robert H. Fernald of Orono, who has also been observer of the other meteorological instruments belonging to the Station.

Hygrometer No. 1 was placed in a wooden stand constructed for thermometrical instruments and located in the open field remote from buildings. Hygrometer No. 2 also was enclosed in a wooden box, perforated to allow a free circulation of air, and located also in the open field. Hygrometer No. 3 was also enclosed in a perforated box attached to a tree in a moderately dense forest. Hygrometer No. 4 was placed in a similar box attached to a tree in a portion of the forest a little more open than that in which No. 3 was located, but near which was a running brook except during the driest part of the summer.

Each hygrometer was about four feet above the surface of the ground. Readings were taken three times daily, at 7 A. M., at 1 P. M., and at 7 P. M., local time, commencing April 5, 1889 and continuing to Nov. 1, 1889. The monthly averages are given in the following tables :

Percentages of Moisture.

HYGROMETER NO. 1.—IN OPEN FIELD.

	7 A. M.	1 P. M.	7 P. M.	Mean.
April,	81	53	66	67
May,	84	60	71	72
June,	88	67	81	79
July,	85	65	75	75
August,	95	70	80	82
September,	93	68	83	81
October,	94	66	79	80
Mean results,	89	64	76	77

HYGROMETER NO. 2.—IN OPEN FIELD.

	7 A. M.	1 P. M.	7 P. M.	Mean.
April,	78	52	65	65
May,	80	53	68	67
June	84	66	74	75
July.	79	60	69	69
August,	87	67	75	76
September,	91	60	81	77
October,	93	66	81	80
Mean results,	85	61	72	73

HYGROMETER NO. 3.—IN FOREST.

	7 A. M.	1 P. M.	7 P. M.	Mean.
April,	81	62	69	71
May,	83	63	73	73
June,	89	80	84	84
July,	94	86	91	90
August,	91	89	93	91
September,	96	88	92	92
October,	96	90	90	92
Mean results,	90	80	85	85

HYGROMETER NO. 4.—IN FOREST.

	7 P. M.	1 P. M.	7 P. M.	Mean.
April,	83	65	77	75
May,	89	66	80	78
June,	92	81	86	86
July,	93	79	87	86
August,	95	86	91	91
September,	96	83	90	90
October,	96	80	90	89
Mean results.	92	77	86	85

PERCENTAGES OF MOISTURE.

SUMMARY FOR SEVEN MONTHS.—APRIL TO NOVEMBER, 1889.

	7 A. M.	1 P. M.	7 P. M.	Mean.
Hygrometer No. 1, in open field,	89	64	76	76
" " 2, " " "	85	61	72	73
" " 3, in forest,	90	80	85	85
" " 4, " "	92	77	86	85

Regarding the mean results from hygrometers Nos. 1 and 2 as indicating percentages for the open field, we have the following summary of results:

	7 A. M.	1 P. M.	7 P. M.	Mean.
Percentages of moisture, open field,	87	62	74	74

Regarding the mean results from hygrometers No. 3 and 4 as indicating percentages for forests only moderately dense, we have the following summary results:

	7 A. M.	1 P. M.	7 P. M.	Mean.
Percentages of moisture, forest,	91	78	86	85

Comparing results, open field and forest, we have excess of moisture in forest above that in open field expressed in percentages.

7 A. M.	1 P. M.	7 P. M.	Mean.
4	16	12	11

It thus appears that from observations covering the period of growth of one season, that the excess of moisture in forest above that of open field in the morning, amounts to but 4 per cent., while in the middle of the day it rises to 16 per cent., and at night-fall drops down to 12 per cent., and that the mean excess for the day is 11 per cent. In a very dense forest the percentage of excess would undoubtedly rise much higher. The presence of patches of forest in any region cannot but exert a marked influence on the hygroscopic conditions of the atmosphere, and this condition, in turn, is an important factor in the growth of vegetation.

It was noticable in the investigation given that proximity to running water during two-thirds of the period of experiment only compensated for the loss of moisture resulting from the more open character of the forest where hygrometer No. 4 was situated as compared with No. 3.

It is designed that this examination of the effect of forests on the moisture of the atmosphere shall be continued.

SOIL TEMPERATURES.

In this investigation a knowledge of the temperature of the soil at different depths, during the growing season, is sought.

The period covered by the experiment was from May 1st to Nov. 1st, with thermometers placed in the soil to the depths of 1, 3, 6, 9, 12, 24 and 36 inches.

The location of the thermometers was in open field (near hygrometer No. 2) in the tract of land assigned to the Station for expermiental purposes and devoted to farm experiments. The character of the soil is regarded, therefore, as representative of that on which the field experiments by the Station are carried on.

A summary of results by monthly averages is given in the annexed tables.

SOIL THERMOMETERS.

	1 inch.			3 inches.			6 inches.			9 inches.			12 inches.			24 inches.			36 inches.		
	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.	7 A.M.	1 P.M.	7 P.M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
May....	51.77	62.92	59.20	51.50	60.33	59.70	52.92	55.21	57.04	53.49	53.31	55.44	52.46	52.15	53.21	48.84	49.06	49.01	46.28	46.42	46.48
June....	61.94	71.54	67.56	61.38	69.62	67.76	61.85	68.43	65.35	62.07	62.27	63.51	61.26	61.10	61.79	57.23	57.43	57.41	54.36	54.54	54.52
July....	63.41	72.10	68.89	63.10	70.86	69.54	64.25	66.51	67.48	64.93	65.15	66.27	64.30	64.02	64.29	60.99	61.14	61.03	58.50	58.62	58.57
August....	61.18	69.59	66.90	61.75	68.91	68.01	62.90	64.83	66.01	59.82	63.88	65.01	63.31	63.10	63.31	60.96	61.10	60.97	59.16	59.31	59.23
September....	57.11	61.56	61.45	57.74	63.01	62.89	59.47	60.25	61.29	60.29	60.20	60.93	60.30	60.21	60.04	59.42	59.51	59.36	58.40	58.51	58.37
October....	42.80	43.59	45.50	43.80	47.31	46.72	46.06	46.48	47.12	47.21	46.97	47.32	48.17	47.83	47.85	50.63	50.65	50.54	51.66	51.66	51.61
Mean....	56.37	63.55	61.58	56.54	63.34	62.44	57.91	60.28	60.71	57.97	58.63	59.75	58.30	58.06	58.41	56.34	56.48	56.39	54.73	54.84	54.79
Mean temperature for six months...	° 60.50			° 60.77			° 59.63			° 58.78			° 58.26			° 56.40			54.79		

In order that comparisons may be made between the soil temperatures at different depths and the air temperature in the same locality, the following table is given:

Thermometer in the open air; locality the same as that of soil thermometers.

	7 A. M.	1 P. M.	7 P. M.	Mean.
	°	°	°	°
May,	52.95	68.30	59.47	60.24
June,	63.36	74.27	68.07	68.57
July,	65.12	75.75	70.86	70.58
August,	59.97	74.20	66.81	66.99
September,	54.39	70.86	61.55	62.27
October,	37.41	52.80	44.05	44.75
Mean,	55.53	69.36	61.80	62.23

TABLE SHOWING CHANGES OF TEMPERATURE IN THE SOIL FOR INCREASED DEPTHS.

Depth of Thermometer.	Mean temperature for six months.	Difference in mean temperature.	Changes in temperature for one inch.
	°	°	°
1 inch....	60.50		
3 inches.......	60.77	+0.27	+0.13
6 inches............	59.63	—1.14	—0.38
9 inches.......	58.78	—0.85	—0.28
12 inches...........	58.26	—0.52	—0.17
24 inches......	56.40	—1.86	—0.15
36 inches............	54.79	—1.61	—0.13

An examination of the tables shows that the soil responds readily to the daily heat of the sun to the depth of three inches, less readily to the depth of six inches, in a moderate degree only to the depth of nine inches, and very slightly below twelve inches. To the depth of three inches the range between the morning and the midday observations has been as high as fifteen degrees. The mean daily range at the depth of 1 inch during the period of observations was 7°.18; at the depth of 3 inches, 6°.80; at the depth 6 inches, 2°.80; at the depth of 9 inches, 1°.78, and below 12 inches, very slight.

At the depth of 3 inches, the average temperature of the soil was somewhat higher than at the depth of 1 inch. The surface soil averaged about six degrees warmer than the soil 36 inches below the surface.

The rate of reduction of temperature with depth below the layer three inches from the surface is clearly shown in the foregoing

table. Comparing soil temperature with the air temperature, it appears that, at the depth of 1 inch, the temperature of the soil was lower than that of the air by 1°.73 ; at the depth of 3 inches, by 1°.46 ; 6 inches, by 2°.60 ; 9 inches, by 3°.45 ; 12 inches, by 3°.97 ; 24 inches, by 5°.83, and at the depth of 36 inches, by 7°.44.

It is proposed to renew to observations with the soil thermometers on the 1st of April, 1890.

Terrestrial Radiation.

It is a well known fact that the heat radiated from the surface of the earth during the night reduces its temperature below that of the surrounding atmosphere. The amount of this radiation or the consequent reduction of temperature is approximately shown by comparing the readings of a terrestrial radiation thermometer with those of a minimum thermometer. In obtaining data for the comparison given below, the minimum thermometer was four feet above the ground and the terrestrial radiation thermometer was within six inches of its surface. The results are based on monthly averages from May to October inclusive.

Table Showing Loss of Heat by Terrestrial Radiation.

	May	June	July	Aug.	Sept.	Oct.	Mean
Mean of minimum temperatures,	46°.63	53°.25	55°.08	53°.05	49°.07	33°.91	48°.50
Mean of Tem. from Ter. Rad. Ther.,	38°.48	49°.20	50°.59	47°.66	44°.60	28°.48	43°.17
Loss of heat by radiation,	8°.15	4°.05	4°.49	5°.39	4°.47	5°.43	5°.33

On cloudy nights the difference in the readings of the two thermometers is small, and on exceptionally clear (dry) nights it is a maximum. The greatest range observed was 10°.8. On the morning of July 2d, the radiation thermometer was the higher, showing that the moist air resting upon the surface of the ground served as a warm blanket, and that the amount of heat absorbed was greater than that radiated. From the table above it appears that the mean radiation was 5°.33.

Solar Radiation.

The temperature of the atmosphere does not indicate the intensity of the sun's heat, as only a small percentage is absorbed as the rays are transmitted through the air. The maximum thermometer in the shade, therefore, does not give the intensity of solar radiation ; neither does exposure of an ordinary thermometer to the direct rays of the sun in consequence of the cooling effects of draughts of air. In order to avoid the effects of currents of air, the *vacuum solar radiation thermometer* has been devised. "This consists of a blackened bulb radiation thermometer inclosed n a glass tube and globe, from which all air is exhausted. Thus

protected from the loss of heat which would ensue if the bulb were exposed, its indications are from 20° to 30° higher, than when placed side by side with a similar instrument with the bulb exposed to the passing air." By the use of this instrument the amounts of solar radiation at different places and in different seasons at the same place are rendered comparable. The relations of solar intensity, as distinct from temperature of the air, to the growth and maturity of crops are worthy of careful investigation. The high solar intensity maintained through the months of August and September in this State, undoubtedly had an important bearing upon the complete ripening of vegetables and fruits and likewise upon their excellent keeping qualities. From the wide range of observations undertaken by Experiment Stations with radiation thermometers, important deductions may reasonably be expected. I subjoin a table of results from the maximum thermometer and the thermometer for solar rediation expressed in monthly averages.

	May	June	July	Aug.	Sept.	Oct.	Mean
Mean of readings, Sun Ther.,	133.02	134.22	139.55	137.56	122.79	105.86	128.83
Mean of Maximum Tem.,	67.85	73.45	75.30	73.72	71.23	52.78	69.05
Excess of solar intensity,	65.17	60.77	64.25	63.84	51.56	53.08	59.78

Wind and Rain.

The velocity of the wind has been determined by a Robinson's Anemometer attached to the Experiment Station building, and the amount of rain by means of a gauge, signal service pattern, located in the same plat as the soil thermometers.

The amount of rain, is, therefore, essentially the same amount that has fallen on the experimental grounds of the Station. The amount is less than normal, but it was so well distributed through the season, that, at no time, did the crops materially suffer. The wind record is the first made in this locality. The table given contains its own explanation:

	Wind.		Rain.
	Mean distance travelled per day. Miles.	Velocity per hour. Miles.	Amount. Inches.
April,	253.93	10.58	1.36
May,	189.83	7.91	1.61
June,	171.12	7.13	4.86
July,	200.33	8.34	3.27
August,	139.35	5.81	1.69
September,	198.06	8.25	2.10
October,	194.31	8.09	3.96
Mean,	192 42	8.02	Total, 18.85

Conclusion.

In order to show more definitely the nature and daily requirements of the meteorological work in progress, I append the records for one month, selecting the month of June. Such records, extending through the several months under notice, have furnished the basis of this bulletin. Only a partial discussion of them has been possible. Their complete discussion involves comparisons with similar data in other years, yet to be obtained. By lapse of time such observations become increasingly valuable, and their thorough discussion adds to the sum of available knowledge, furnishing rules for guidance useful alike for the scientist and the farmer.

HYGROMETER NO. 1.—IN OPEN FIELD.

JUNE, 1889.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°		°	°	°		°	°	°	
1.	63.2	62.0	61	94	74.8	66.8	63	66	67.3	64.3	62	85
2.	61.6	61.0	61	97	66.7	65.5	65	94	65.0	62.5	61	87
3.	59.7	59.2	59	97	66.8	62.4	60	78	60.1	58.9	58	93
4.	58.0	57.2	56	95	64.0	62.5	62	92	61.6	60.8	60	96
5.	59.2	58.2	57	94	60.0	58.2	57	90	60.3	59.3	58	94
6.	55.7	55.2	55	97	65.1	58.3	53	66	59.8	56.8	55	84
7.	52.6	50.0	48	84	65.0	56.8	49	55	64.8	55.8	49	56
8.	58.0	57.0	56	94	61.0	59.3	59	91	60.8	59.2	59	91
9.	61.8	60.3	60	92	64.8	63.3	63	92	60.3	59.6	59	96
10.	59.5	59.5	59.5	100	72.7	70.0	70	87	67.8	66.4	66	93
11.	67.8	66.8	67	95	80.7	71.7	68	65	71.3	67.2	65	81
12.	66.0	62.8	61	84	70.8	62.6	58	63	66.2	60.8	57	73
13.	62.7	60.3	59	87	75.0	65.1	59	58	68.8	64.7	63	80
14.	57.1	54.0	52	83	69.6	58.0	50	50	64.6	60.7	59	80
15.	60.8	50.8	41	49	70.5	66.2	64	80	68.2	67.0	67	94
16.	65.0	60.2	57	76	73.6	64.0	59	66	65.8	62.0	60	81
17.	64.0	63.6	63.2	98	73.3	64.0	58	60	60.2	58.7	58	92
18.	47.3	44.0	40	77	63.7	55.0	48	57	56.2	53.8	52	86
19.	51.4	49.7	48	89	66.7	55.7	47	49	60.8	55.0	50	69
20.	59 4	57.0	55	87	76.8	67.2	61	61	72.0	62.3	57	58
21.	67.8	62.3	59	74	80.2	68.2	62	54	68.0	63.0	60	76
22.	65.2	65.0	64.5	99	65.2	65.0	64.5	99	67.0	66.0	66	95
23.	56.8	50.2	46	65	65.6	56.3	49	55	66.4	57.1	49	56
24.	56.1	52.8	50	81	69.0	59.0	52	55	59.2	52.2	46	62
25.	55.6	54.1	54	91	72.5	64.0	60	63	62.8	58.4	55	77
26.	58.2	57.3	56	94	71.2	60.9	54	55	59.6	55.1	52	75
27.	63.6	62.4	61	94	76.2	71.0	69	77	69.8	69.0	69	96
28.	65.3	65.0	64.5	98	78.8	69.3	65	62	67.2	64.0	62	84
29.	69.3	67.9	67	93	83.2	73.6	69	64	72.8	67.4	65	75
30.	71.0	66.9	65	81	85.6	74.9	71	61	81.0	72.2	68	65
Means.				.88				.67				.81
Mean for month.					.79							

HYGROMETER NO. 2.—IN OPEN FIELD.

JUNE, 1889.

Day.	7 A. M. Dry Bulb	7 A. M. Wet Bulb.	7 A. M. Dew Point.	7 A. M. Humidity.	1 P. M. Dry Bulb.	1 P. M. Wet Bulb.	1 P. M. Dew Point.	1 P. M. Humidity.	7 P. M. Dry Bulb.	7 P. M. Wet Bulb.	7 P. M. Dew Point.	7 P. M. Humidity.
	°	°	°		°	°	°		°	°	°	
1.	65.3	63.2	62	90	76.6	68.3	63	62	67.3	64.7	63	88
2.	62.4	61.1	60	93	68.0	66.5	66	93	65.8	62.3	51	82
3.	60.6	59.0	59	92	72.7	65.1	61	67	62.2	59.2	57	84
4.	59.0	57.7	57	93	66.0	63.8	63	89	62.6	61.6	61	95
5.	61.6	60.0	60	92	61.9	59.0	57	84	61.0	59.1	59	95
6.	57.0	56.0	55	94	68.0	60.2	55	64	63.9	58.1	56	75
7.	54.0	50.2	46	77	66.6	57.0	50	55	69.2	58.3	50	51
8.	58.8	57.2	57	90	63.3	60.0	57	83	62.8	59.9	58	85
9.	64.2	61.2	59	85	67.3	64.8	63	88	61.8	59.9	59	90
10.	60.6	59.8	59	95	78.0	72.2	69	76	69.8	67.2	67	88
11.	71.0	69.0	68	91	85.6	74.8	71	61	73.5	68.0	66	76
12.	66.3	62.0	59	79	71.6	62.2	57	59	67.7	61.3	57	69
13.	69.8	64.0	61	72	77.3	66.3	76	95	72.0	65.5	62	71
14.	58.6	55.0	53	80	70.8	58.8	51	48	70.7	62.8	58	64
15.	66.0	62.8	61	84	74.5	68.8	67	75	72.3	70.1	69	90
16.	66.7	61.6	59	76	77.3	65.2	58	52	70.9	63.9	60	68
17.	65.1	63.8	63	93	75.0	64.8	59	57	60.6	50.0	50	70
18.	51.2	47.1	43	74	69.3	57.8	49	49	60.7	51.1	42	50
19.	58.2	55.0	53	82	72.5	64.8	61	66	64.2	60.9	58	83
20.	65.9	62.4	61	82	78.8	68.2	63	58	74.2	63.0	56	53
21.	74.2	66.9	63	69	84.5	69.8	62	47	74.0	65.0	60	62
22.	67.0	65.5	65	93	67.3	66.3	66	95	68.5	66.4	65	88
23.	58.0	51.2	45	62	66.1	56.3	49	54	71.5	60.1	53	51
24.	61.0	61.0	53	75	70.7	59.8	53	52	61.0	55.8	52	72
25.	58.7	58.7	55	85	79.2	67.6	61	55	67.7	60.8	56	67
26.	59.2	58.0	57	93	76.2	63.7	56	50	63.4	56.8	52	67
27.	65.7	63.0	62	86	81.4	73.2	70	68	71.0	69.0	68	91
28.	71.0	68.1	67	86	84.8	72.0	66	53	69.6	65.0	63	79
29.	68.4	66.0	64	88	88.6	76.6	72	58	76.1	68.8	66	69
30.	75.2	69.2	66	74	87.2	75.0	70	57	86.1	74.8	71	60
Means.				.84				.66				.74
Mean for month.							.75					

HYGROMETER NO. 3.—IN FOREST.

JUNE, 1889.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°		°	°	°		°	°	°	
1.	62.3	60.7	60	91	74.0	68.2	65	75	67.3	64.2	62	85
2.	61.9	60.9	60	95	65.4	64.9	64	97	64.2	62.6	62	92
3.	58.7	57.3	57	92	65.7	63.2	62	87	61.7	60.2	60	92
4.	57.7	56.2	56	91	62.9	61.2	61	91	62.2	60.8	60	93
5.	58.8	57.4	57	92	60.0	58.6	58	92	60.2	59.0	58	93
6.	55.5	54.2	54	92	64.0	60.1	57	79	56.8	55.0	54	89
7.	50.8	49.0	47	88	61.0	56.2	52	74	61.3	58.0	55	82
8.	57.0	55.6	55	92	61.0	59.6	59	92	60.0	58.1	57	90
9.	59.9	58.9	58	94	63.2	62.3	61	95	61.2	60.0	59	93
10.	58.3	57.2	56	94	70.0	69.0	69	95	66.0	65.0	64	95
11.	65.1	64.0	63	95	75.0	72.6	72	89	71.1	68.3	67	87
12.	63.9	61.9	61	90	68.1	62.1	58	71	67.0	62.0	59	76
13.	59.3	57.2	56	89	74.8	65.3	59	60	71.0	66.0	63	77
14.	56.7	53.9	52	84	67.0	58.2	52	58	66.2	61.8	59	78
15.	58.0	55.8	55	88	70.7	67.6	67	86	67.4	64.3	62	85
16.	62.7	60.8	60	89	70.8	65.2	62	74	67.0	63.8	62	84
17.	62.6	60.4	59	88	71.0	66.0	62	75	60.3	54.8	50	70
18.	44.3	41.7	38	81	60.2	55.0	51	72	58.6	54.0	51	75
19.	49.0	46.0	43	80	63.9	58.0	54	70	61.0	57.2	54	79
20.	58.2	56.0	55	88	75.4	68.7	65	71	70.8	64.8	62	72
21.	63.4	60.3	58	84	78.3	71.2	68	71	69.6	65.6	63	81
22.	66.3	64.8	64	92	66.3	64.8	64	92	66.8	64.7	64	90
23.	56.7	53.0	50	79	66.4	58.0	51	59	63.0	59.0	56	79
24.	52.6	50.6	49	87	67.2	61.8	58	73	62.3	58.6	56	80
25.	52.0	50.1	48	87	69.3	65.2	63	81	64.3	60.4	57	79
26.	54.8	53.5	53	92	68.9	60.7	56	62	61.7	57.2	54	76
27.	63.2	57.1	53	69	75.2	72.2	71	87	70.0	68.6	68	93
28.	63.0	62.0	61	95	74.6	72.8	72	92	69.1	67.0	66	90
29.	62.9	61.4	61	92	76.8	73.7	73	87	73.0	71.0	70	91
30.	66.6	65.1	65	93	77.6	74.0	73	85	77.3	72.8	70	80
Means.				.89				.80				.84
Mean for month.						.84						

HYGROMETER NO. 4.—IN FOREST.

June, 1889.

Day.	7 A. M.				1 P. M.				7 P. M.			
	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.	Dry Bulb.	Wet Bulb.	Dew Point.	Humidity.
	°	°	°		°	°	°		°	°	°	
1.	62.8	62.0	61	96	73.5	67.7	65	74	66.5	64.5	64	90
2.	62.0	61.0	60	95	65.5	65.2	64.5	98	63.8	62.0	61	91
3.	59.0	58.9	57	94	65.0	63.1	62	90	61.3	59.2	58	89
4.	58.0	57.0	56	94	62.3	61.5	60	95	62.9	62.0	61	95
5.	59.4	58.0	57	92	59.8	58.8	58	94	59 6	59.0	59	97
6.	55.4	55.1	54.5	98	63 3	60.2	58	84	57.0	55.3	55	90
7.	51.0	50.0	49	93	61.5	57.0	54	76	60.9	56.0	52	74
8.	57.3	56.8	56	97	59.9	59.0	58	95	59.5	59.0	59	97
9.	59.8	59.0	58	95	63.0	62 5	62	97	60.7	59.8	59	95
10.	59.2	58.9	58.5	98	69.9	69.2	70	97	66.1	65.4	65	96
11.	65.3	64.8	64	97	75.0	72.3	72	88	71.0	68.2	67	87
12.	63.6	62.5	62	95	68.1	62.2	58	71	66.6	62.0	60	77
13.	60.4	59.0	58	92	74.1	66.8	63	69	69.1	65.6	63	83
14.	56.1	54.3	53	89	67.4	59.1	53	61	64.5	61.3	59	84
15.	58.2	57.0	56	93	70.3	68.2	67	90	65.8	64.3	64	92
16.	62.0	61.0	60	95	70.6	65.3	62	76	65.4	62.7	61	86
17.	63.0	62.0	61	95	70.0	67.0	66	86	58.2	54.0	51	77
18.	44.1	41.9	39	83	59.8	54.1	50	69	55.2	50.8	47	73
19.	48.3	46.7	45	89	63.2	55.3	49	61	60.2	56.0	53	77
20.	59.0	57.0	56	89	75.4	68.1	64	69	69.0	64.2	61	77
21.	64.0	61.0	59	85	77.8	69.1	66	64	68.8	64.2	62	78
22.	66.0	65.0	64	95	66.0	65.0	64	95	66.6	65.2	65	93
23.	55.8	52.0	49	78	62.9	57.3	54	72	61.0	57.8	56	83
24.	52.0	50.6	49	90	66.2	59.9	55	69	61.6	56.9	53	75
25.	52.0	50.9	50	94	69.0	64.3	61	77	63.0	59.8	58	83
26.	55.0	54.0	53	94	68.0	62.0	58	71	60.3	57.7	56	86
27.	63.0	57.2	53	70	75.3	72.0	70	85	70.0	68.7	68	94
28.	63.3	62.8	62	97	74.2	72.0	71	90	68.3	66.2	65	90
29.	62.7	61.7	61	95	76.8	73.0	71	84	71.6	68.7	68	86
30.	67.0	65.1	64	90	78.8	72.6	69	74	76.1	72.1	70	82
Means.				.92				.81				.86
Mean for month.					.86							

SOIL THERMOMETERS.

JUNE, 1889.

Day.	Depth, 1 inch.			Depth, 3 inches.			Depth, 6 inches.			Depth, 9 inches.			Depth, 12 inches.			Depth, 24 inches.			Depth, 36 inches.		
	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.	7 A. M.	1 P. M.	7 P. M.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
1.	63.0	76.3	69.7	61.9	72.5	70.3	60.5	63.7	66.0	59.7	60.5	62.6	57.6	57.8	68.7	53.0	53.3	53.5	50.6	50.7	50.7
2.	64.0	67.1	63.3	63.5	65.1	66.1	62.4	62.6	63.4	62.0	61.6	61.8	59.6	59.8	59.7	54.0	54.3	54.3	51.0	51.1	51.1
3.	61.6	73.0	66.5	61.0	69.5	67.2	61.0	62.8	64.3	61.0	61.0	62.2	59.7	59.7	60.0	54.6	54.8	54.9	51.5	51.6	51.7
4.	61.6	65.3	65.4	61.5	64.2	65.2	61.3	61.6	62.3	61.2	60.7	61.0	60.0	59.7	59.6	55.0	55.1	55.2	51.7	52.0	52.0
5.	62.0	66.0	64.7	60.9	66.0	64.7	60.5	62.4	62.6	60.5	60.6	61.2	59.6	59.4	59.7	55.3	55.3	55.3	52.1	52.2	52.3
6.	60.1	73.7	65.5	60.0	69.8	65.9	60.0	62.3	63.5	60.4	60.5	61.7	59.5	59.4	60.0	55.4	55.6	55.5	52.4	52.5	52.5
7.	57.0	68.0	65.7	57.5	66.2	59.1	59.1	60.5	62.6	60.0	59.8	60.9	59.5	59.0	59.2	55.5	55.7	55.6	52.5	52.8	52.8
8.	58.3	64.4	62.9	58.0	63.0	62.5	58.7	59.6	60.4	59.5	59.3	59.6	59.0	58.6	58.6	55.8	55.7	55.7	53.0	53.0	53.0
9.	62.0	65.0	63.8	60.5	63.5	63.5	59.3	60.6	61.2	59.2	59.5	60.0	58.5	58.5	58.6	55.6	55.7	55.6	53.1	53.1	53.1
10.	60.6	70.3	66.0	60.2	66.5	65.9	59.9	61.1	63.0	59.6	59.9	61.2	58.9	58.9	59.3	55.6	55.8	55.8	53.1	53.2	53.3
11.	65.0	80.0	72.6	63.5	74.5	72.5	62.0	65.0	67.2	61.1	62.0	64.0	60.0	60.2	61.1	55.9	56.3	56.3	53.3	53.5	53.5
12.	65.6	73.3	69.6	65.0	71.0	70.5	64.5	65.4	66.9	63.8	63.9	64.9	62.1	62.1	62.3	56.6	57.0	57.0	53.5	53.7	53.8
13.	62.4	77.5	71.0	61.7	73.5	70.4	63.0	65.3	67.1	63.5	63.5	65.9	62.5	62.0	62.6	57.3	57.5	57.5	54.0	54.2	54.2
14.	61.4	73.5	68.9	61.7	71.7	69.7	63.4	65.0	66.8	63.9	63.6	65.0	63.0	62.4	62.6	57.7	57.9	57.9	54.4	54.7	54.7
15.	62.0	70.3	67.1	61.0	69.0	67.4	62.4	64.4	65.9	63.3	63.3	64.9	62.4	62.1	62.4	58.0	58.2	58.2	54.7	55.0	55.0
16.	64.7	74.9	70.2	64.0	74.6	71.0	63.8	67.0	68.0	63.6	64.3	65.5	62.7	62.7	63.1	58.2	58.5	58.5	55.0	55.2	55.2
17.	65.2	72.1	64.2	65.0	71.0	66.1	64.9	65.6	66.0	64.7	64.5	65.0	63.5	63.2	63.3	58.6	58.8	58.8	55.3	55.5	55.5
18.	54.5	68.6	65.0	55.2	67.5	66.1	60.0	61.8	63.5	62.0	61.3	62.3	62.1	61.3	61.0	58.8	58.9	58.7	55.5	55.6	55.6
19.	53.3	70.5	66.1	56.0	69.0	66.4	59.0	62.0	63.5	60.5	60.5	62.0	60.6	60.6	60.6	58.3	58.5	58.2	55.6	55.8	55.8
20.	62.0	74.4	68.0	61.5	72.3	68.3	61.5	64.0	65.7	61.6	61.5	63.7	61.0	61.0	61.7	58.1	58.3	58.2	55.7	55.8	55.7
21.	63.3	76.2	70.8	62.5	74.6	71.1	62.8	66.0	67.5	63.0	63.5	65.4	62.0	62.0	62.9	58.4	58.5	58.7	55.7	56.0	55.9
22.	66.1	66.6	64.3	65.6	65.9	65.7	64.5	65.2	66.4	64.2	64.4	66.1	63.2	63.2	63.7	59.0	59.1	59.4	56.0	56.3	56.1
23.	61.3	66.6	64.2	60.5	67.0	65.5	61.9	63.4	64.4	62.7	62.7	63.5	62.5	62.1	62.1	59.0	59.2	59.0	56.1	56.3	56.3
24.	57.4	66.9	63.6	57.0	67.2	64.9	60.0	62.7	63.7	61.1	61.6	62.6	61.5	61.0	61.1	59.0	59.0	58.8	56.2	56.5	56.3
25.	57.2	69.9	66.5	56.7	67.5	67.1	59.5	61.7	64.0	61.0	60.9	62.3	60.9	60.5	60.8	58.6	58.8	58.6	56.2	56.5	56.3
26.	59.0	70.0	66.3	28.5	68.8	67.2	60.4	63.0	65.9	60.3	62.7	63.3	61.0	60.8	61.4	58.4	58.7	58.5	56.2	56.4	56.3
27.	65.6	74.4	70.4	64.6	71.5	70.7	63.0	64.5	67.0	62.5	63.0	64.7	61.6	61.8	63.0	58.5	58.7	58.9	56.2	56.4	56.3
28.	65.0	76.0	71.4	64.2	73.6	72.2	64.2	66.7	69.8	64.4	64.7	66.3	63.4	63.4	63.9	59.0	59.2	59.2	56.5	56.5	56.5
29.	66.0	77.5	74.2	65.5	76.5	74.7	65.5	68.3	70.3	65.4	66.0	67.6	64.4	64.4	64.8	59.5	59.9	59.9	56.6	57.0	56.8
30.	68.0	77.9	76.1	66.6	75.7	76.0	66.5	68.6	71.6	66.5	66.8	68.9	65.4	65.4	66.0	60.2	60.5	60.6	57.0	57.2	57.2
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Means...	61.94	71.54	67.56	61.38	69.62	67.76	61.85	68.43	65.35	62.07	62.27	63.51	61.26	61.10	61.79	57.23	57.43	57.41	54.36	54.54	54.52

June, 1889.

Day.	Maximum and Minimum Thermometers. Maximum.	Minimum.	Terrestrial Radiation Thermometer.	Solar Thermometer.	Precipitation Time of beginning.	Time of ending.	Amount of rain. Inches.	Anemoneter observed at 1 P. M. Movement of Wind. Number of miles in last twenty-four hours.	Average velocity per hour, miles.
	°	°	°	°					
1.	75.0	59.3	58.1	150.5	7 P. M.			361.3	15.05
2.	69.9	60.2	60.0	109.5		Night.	.88	252.8	10.53
3.	67.7	59.1	55.0	134.8				279.6	11.65
4.	64.8	55.9	52.2	88.8	Early Morning.	Night.	.40	123.0	5.13
5.	68.0	55.0	52.8	129.0	11.30 A. M.	9 A. M.	.52	136.9	5.71
6.	69.0	53.8	53.4	149.8	3.30 P. M.	4.30 P. M.	.04	131.4	5.48
7.	69.2	47.3	41.3	145.3				123.4	5.14
8.	63.1	47.5	41.3	104.0	4.30 A. M.	4 P. M.	.25	221.2	9.22
9.	65.0	56.3	54.4	91.1	9.30 A. M.	Night.	.29	125.0	5.22
10.	74.0	56.0	55.8	121.9	4 P. M.	6.30 P. M.	.25	129.7	5.40
11.	81.1	61.3	60.9	146.2	6.40 P. M.	7.15 P. M.	.02	121.3	5.05
12.	74.2	60.3	57.2	143.0				192.9	8.04
13.	77.9	54.8	46.8	143.2	9 40 P. M.	10 P. M.	.01	201.5	8 35
14.	74.7	53.9	50.0	140.7				254.0	10.58
15.	73.0	49.9	46.1	132.2	7 P. M.	Night.	.68	129.6	5.40
16.	77.2	49.8	46.0	146.0				175.8	7.33
17.	75.6	60.4	58.8	145.1	6 A. M.	9.30 A. M.	.13	149.2	6.22
18.	65.8	37.7	29.1	133.0				160.9	6.70
19.	67.1	41.2	34.9	135.0				142.1	5.92
20.	79.9	54.4	52.2	148.1				128.1	5.34
21.	81.2	61.3	60.8	147.3				261.6	10.90
22.	69.2	59.0	55.0	112.2	Early Morning.	4 P. M.	.53	301.0	12.54
23.	69.2	48.7	40.0	143.6				212.3	8.85
24.	69.8	46.9	38.2	128.2				123.7	5.15
25.	74.0	43.9	37.8	124.9				84.3	3.51
26.	72.2	43.8	37.9	143.3	8 P. M.			182.3	7.60
27.	80.0	47.6	43.8	147.5	4 P. M.	9 A. M. 6 A. M.	.05 .69	225.4	9.39
28.	82.7	56.8	52.1	144.6	4 P. M.	5 P. M.	.12	66.0	2.75
29.	84.7	57.9	54.1	149.0				42.9	1.79
30.	88.3	57.6	49.9	148.7				94.3	3.93
					Total,		4.86 In	5133.5	
Means.	73.45	53.25	49.20	134.22				171.1	7.13
								Mls. per day.	Mls. per hour.

THE COEFFICIENTS OF DIGESTIBILITY FOR PROTEIN.

W. H. JORDAN AND L. H. MERRILL.

The reports of this Station for 1886-7, pp. 127 to 135, and 1888, pp. 195-203, contain the results of an attempt to study the error involved in the usual method of determining the digestibility of protein. Several facts were very clearly shown, which are in part only a confirmation of the results previously obtained by German investigators. The data in the reports referred to show; (1st) that the coefficients of digestibility for protein as ordinarily determined are very much smaller than those obtained by pepsin-pancreas digestion; (2nd) that in the cases tested from fourteen to thirty-five per cent. of the fæcal nitrogen was soluble under conditions that presumably would cause no extraction of albuminoid compounds; (3rd) that the average coefficients of digestibility as determined by the use of artificial pepsin and pancreas solutions are practically the same as those obtained when allowance is made for the fæcal nitrogen soluble in ether, alcohol, hot water and limewater. A study of this question has been continued in connection with the digestion trials which are previously described in this report, and with results almost identical with those formerly obtained.

Of the three methods tried in 1888, for the separation of the biliary and other waste products of the fæces, only one was used in connection with the work here reported, namely; method B, which consists in the extraction of the fæces with ether, the same as for the fat extraction, followed by successive extractions with hot alcohol and hot water for about ten minutes each, this treatment being followed by extraction with lime water, which consists in letting one gram of the substance stand in a cold, saturated solution of lime water for six hours. The following table shows the percentage of nitrogen that was dissolved by this treatment:

Excrements from		In water-free substance.			Per cent. of total nitrogen extracted by Method B.
		Total Nitrogen.	Nitrogen after extraction by Method B.	Nitrogen extracted by Method B.	
Timothy early-cut,	Sheep 1	1.54	1.03	.51	33.1
	Sheep 2	1.62	1.12	.50	30.8
Timothy late-cut,	Sheep 1	1.55	1.21	.34	21.6
	Sheep 2	1.38	1.07	.31	22.4
Oat Grass,	Sheep 3	1.81	1.39	.42	23.2
	Sheep 4	1.54	1.09	.45	29.2
Red Top,	Sheep 1	1.41	1.09	.32	22.5
	Sheep 2	1.49	1.13	.36	24.2
Blue Joint,	Sheep 3	1.53	1.09	.44	28.7
	Sheep 4	1.55	1.09	.46	29.7
Witch Grass,	Sheep 1	1.69	1.12	.57	33.7
	Sheep 2	1.44	1.01	.43	29.8
Alsike Clover,	Sheep 3	1.83	1.40	.43	23.5
	Sheep 4	1.89	1.39	.50	26.4
South Corn Fodder,	Sheep 1	2.48	1.86	.62	25.0
	Sheep 2	2.18	1.64	.54	24.7
Field Corn Fodder,	Sheep 3	2.53	1.84	.69	27.6
	Sheep 4	2.60	1.81	.79	30.4
Sweet Corn Fodder,	Sheep 3	2.41	1.69	.72	29.9
	Sheep 4	1.87	1.53	.34	18.2
South Corn Ensilage,	Sheep 1	2.33	1.78	.55	23.6
	Sheep 2	2.40	1.74	.66	27.5
Field Corn Ensilage,	Sheep 3	3.23	2.52	.71	21.9
	Sheep 4	2.50	1.88	.62	24.9
Sweet Corn Ensilage,	Sheep 1	2.69	2.10	.59	21.9
	Sheep 2	2.82	2.05	.77	27.3

It appears from the above that from eighteen to thirty-three per cent. of the nitrogen of the fæces was extracted.

In the report for 1888, the question is raised whether solvents used in method B extracted any compounds that properly belong to the undigested residue of the food, such as peptones, amides, or even albuminoids. It has previously been shown that the cold lime water has no appreciable effect on the albuminoids. (See Rep. Me. Exp't Station, 1888, pp. 202-3.)

The hot water is the only other solvent which is likely to remove albuminoids, and the presence of these compounds in this solution has been tested by adding to it copper hydrate before filtering, in the same manner as in Stutzers method for the separation of albuminoid and amide nitrogen. The amount of nitrogen extracted with and without the use of copper hydrate in the water solution was compared in the cases of the excrements of six sheep,

and there was found to be practically no difference in the two methods, as is shown by the following table. Certainly nitrogen compounds that would be thrown down by the hydrate of copper are but slightly, if at all, brought into the solution by the hot water.

Excrement from		In water-free substance. Total Nitrogen.	Nitrogen in residue after extraction by Method B.	Nitrogen in residue after extraction by Method B, copper hydrate added to water solution.
Timothy, Early Cut,	Sheep 1.....	1.54	1.03	1.04
	Sheep 2.....	1.62	1.12	1.14
Red Top Wheat Bran,	Sheep 3.....	1.74	1.26	1.36
	Sheep 4.....	1.60	1.30	1.25
Ted Top Fancy Middlings,	Sheep 1.....	2.02	1.42	1 48
	Sheep 2.....	2.11	1.45	1.53

The existence of amide compounds in the fæces, such as acid amides or amido-acids, can be detected by the action of nitrous acid, compounds of this class being decomposed with the evolution of free nitrogen.

In three cases a determination has been made of the amount of nitrogen obtained by the action of nitrous acid upon the alcohol and hot water extracts from the fæces, and the figures given below show that only a very small quantity of true amides was present:

Excrement from	Amide nitrogen from alcoholic extract, 5 grams substance.	Amide nitrogen from hot water extract, 5 grams substance.	Total per cent. amide nitrogen in feces.
			%
Red Top..................	.92 c.c.	1.39 c.c.	.058
Field Corn..................	1.62 c.c.	1.62 c.c.	.08
Red Top, Fancy Middlings, ...	3.00 c.c.	1.82 c.c.	.12

The test for peptones was found to be somewhat difficult and unsatisfactory because of the fact that the phospho-tungstic acid precipitated such a variety of compounds in the fæcal extract. It was found, however, after clearing the solution supposed to contain the peptones as much as possible by the action of other precipitants, that the precipitated formed from the addition of phospho-tungstic acid contained but a very small amount of nitrogen,

too small, in fact, to entitle it to serious consideration. Of the nitrogen compounds extracted by method B, we have no knowledge of any likely to be present, outside of the albuminoids, peptones and amides, that can properly be classed with the undigested residue. The observations so far made all point to the conclusion, that nearly all the nitrogen extracted by this method belongs to the biliary and other waste products which are only incidentally present in the fæces.

A comparison of the digestion coefficients of protein as found in the ordinary manner, after correction by method B, and by the artificial pepsin pancreas digestion, is made below:

Hays, Fodders and Ensilage.	Coefficients of digestibility of protein.		
	By usual method with animals.	Usual method with animals corrected by Method B.	By pepsin-pancreas digestion.
Timothy Hay early-cut	58.9	72.2	73.3
" " late-cut	50.	61.3	63.9
Wild Oat Grass Hay	68.	77.4	70.
Red Top Hay	62.2	71.3	74.3
Blue Joint Hay	70.2	79.	71.8
Witch Grass Hay	52.9	68.8	76.8
Alsike Clover Hay	68.2	76.2	76.6
South Corn Fodder	58.1	68.5	67.
Field Corn Fodder	63.6	74.1	72.
Sweet Corn Fodder	59.	69.2	70.
South Corn Ensilage	46.6	60.3	69.3
Field Corn Ensilage	52.8	64.1	76.7
Sweet Corn Ensilage	54.1	65.3	78.
	58.8	69.8	72.3

These results are strikingly similar to those obtained in 1888, when the coefficients found by the use of method B were ten and four-tenths per cent. higher than where the correction was not applied, and here we see the difference is eleven per cent. Moreover the method with animals after applying the correction agrees in both instances very closely with the results obtained by the use of artificial pepsin and pancreas solutions.

It is a question whether we can any longer afford to ignore this difference of ten per cent., which must be wholly or in very large part due to compounds that do not properly belong to the undigested residue. The fact that the error introduced in this way affects the apparent digestibility of protein in hays and other coarse fodders much more than in the case of concentrated nitrogenous foods is a strong argument for applying a correction whenever we are reasonably sure that we have arrived at one that is fairly accurate.

LOSS OF FOOD AND MANURIAL VALUE IN SELLING SWEET CORN.

J. M. Bartlett.

Sweet corn is now so important a crop throughout the State that it is believed that it may very properly become a subject of investigation and experiment. A beginning has been made in this direction the past season, the chief object of the work being to get some idea of the composition of the sweet corn plant and of the amount of fertilizing material taken up by the crops, and also to learn something of its distribution through the different parts of the plant. In this way we shall become able to estimate the loss occassioned to the land by the sale of the kernel, and the value of the stalks and the waste products (husks and cobs) for food and manure. Four lots of corn were planted, and owing to a part of it failing to grow the amount of fertilizing material taken from a given area of land cannot be stated; but the relation weights, calculated to water-free substance of stalks, husks, kernel and cobs are shown in table No. 1 below, also the per cent. of nitrogen, phosphoric acid and potash they contain. From these figures the distribution of manurial ingredients can be early estimated. It can be seen that the kernel contains only about 21 per cent. of the total phosphoric acid, 22 per cent. of the potash and 41 per cent. of the nitrogen. Consequently if the stalks, husks and cobs are returned to the farm, quite a large percentage of the fertililzing ingredients is saved. Of the total dry matter in the plant the kernels contained about 15 per cent. In table No. 2 is given the total moisture of the undried stalks, husks, kernels and cobs, and their approximate analysis calculated on a water-free basis. Other experiments are to be carried on in 1890 in which the food value of the plant and its different parts will be given more attention.

TABLE NO. 1.

		Dry matter. Pounds in 100 lbs. of whole plant.	Manurial ingredents. Nitrogen.	Potash K_2O.	Phosporic Acid
		lbs.	lbs.	lbs.	lbs.
Lot I.	Stalks.	60.4	1.64	2.14	.743
	Husks.	4.75	1.35	1.82	.846
	Kernels.	17.9	2.34	1.25	.331
	Cobs.	16.95	1.13	1.10	.265
Lot II.	Stalks.	64.3	1.08	2.09	.746
	Husks.	8.61	1.55	1.57	.668
	Kernels.	11.64	2.54	1.27	.451
	Cobs.	15.45	1.07	1.06	.268
Lot III.	Stalks.	61.85	1.31	2.24	.597
	Husks.	8.00	1.06	1.40	.341
	Kernels.	16.64	2.72	1.46	.422
	Cobs.	15.95	1.01	1.07	.267
Lot IV.	Stalks.		1.65	1.98	.760
	Husks.		1.19	1.54	.294
	Kernels.		2.85	1.51	.436
	Cobs.		1.06	1.12	.246

TABLE NO. 2.

Station Number.		Total per cent. of moisture.	100 parts water-free substance contain Ash.	Protein Nx6.25.	Fiber.	Nitrogen free Extractive Matter.	Ether Extract.
CIII.	Stalks.	79.46	7.36	10.25	23.13	56.77	2.49
CIV.	"	83.00	6.42	6.77	24.61	60.80	1.46
CV.	"	82.00	6.26	8.20	23.96	60.18	1.40
CVI.	"	79.00	6.09	10.36	21.20	59.74	2.61
CVII.	Husks.	89.92	4.93	8.45	27.62	57.22	1.78
CVIII.	"	85.60	3.76	9.71	24.16	64.11	1.26
CIX.	"	85.68	3.97	6.66	23.78	63.88	1.71
CX.	"	83.56	3.63	7.44	26.45	60.94	1.54
CXI.	Kernels.	80.19	2.64	14.64	2.81	74.95	4.96
CXII.	"	84.41	2.97	16.22	3.27	72.10	5.44
CXIII.	"	80.97	3.14	17.03	2.59	72.19	5.05
CXIV.	"	83.87	3.24	17.83	3.78	69.99	5.16
CXV.	Cobs.	81.34	2.71	7.08	28.5	58.64	3.07
CXVI.	"	79.44	2.43	6.69	28.5	59.92	2.46
CXVII.	"	79.06	2.84	6.29	27.94	60.28	2.65
CXVIII.	"	80.58	2.46	6.66	28.43	59.92	2.53

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